Appendix A

- **45 SW, FAA, and NASA Memo of concurrence**
- **Florida CLEARINGHOUSE EA Review Concurrence Letter**
- **NMFS Email Concurrence on Informal Consultation Results**

G.E.A.R.
Gator Engineering & Aquifer Restoration, Inc.

MEMORANDUM

DATE: May 30, 2014

TO: USAF 45th Space Wing; Eva Long
COPY: SpaceX; Mr. Matthew Thompson, Mr. Kary Policht

FROM: GEAR, Mr. John Kaiser, Project Manager

SUBJECT: Falcon 9 Vertical Landing at LC-13 Environmental Assessment (EA) Kick-Off Meeting; Agency Participation

This Memo confirms our discussion on Thursday May 30, 2014 concerning Agency responsibility for the review of the subject EA. Originally, during the initial kick-off meeting held by conference call the attendees agreed that U.S. Air Force 45th Space Wing would be the "Lead Agency", while the FAA would be a "Cooperating Agency".

During our discussion today, and based on your email with Mr. Donald Dankert from NASA at KSC, it was determined that NASA would also be considered a "Cooperating Agency" and therefore would be included in the review cycle for all EA related documentation.

Carrying forward the original discussion and agreements; development and review of this EA is considered a "Fast Track" EA, and draft versions of the EA would be submitted for scheduled reviews via email.

DATE: 5-30-14

John P. Kaiser PMP

185 MIDDLE STREET, SUITE 1351
Lake Mary, FL 32746
PH: 407.878.0950 FAX 407.878.0949

From: Milligan, Lauren [mailto:Lauren.Milligan@dep.state.fl.us]
Sent: Friday, September 26, 2014 3:40 PM
To: John Kaiser
Subject: RE: Draft Final EA for SpaceX Proposed Landing event at LC-13 CCAFS - State Clearance Letter

Mr. John P. Kaiser, PMP, Project Manager
Gator Engineering & Aquifer Restoration, Inc.
185 Middle Street, Suite 1351
Lake Mary, FL 32746-3635

RE: Department of the Air Force – Draft Final Environmental Assessment for the SpaceX Vertical Landing of the Falcon Vehicle and Construction at Launch Complex 13 at Cape Canaveral Air Force Station – Brevard County, Florida.
SAI # FL201409227026C

Dear John:

Florida State Clearinghouse staff has reviewed the referenced Draft Final Environmental Assessment (EA) under the following authorities: Presidential Executive Order 12372; § 403.061(42), *Florida Statutes*; the Coastal Zone Management Act, 16 U.S.C. §§ 1451-1464, as amended; and the National Environmental Policy Act, 42 U.S.C. §§ 4321-4347, as amended.

Based on the information contained in the Draft Final EA and comments received from the Florida Department of State-SHPO, the state has determined that, at this stage, the proposed federal action is consistent with the Florida Coastal Management Program (FCMP). The state's continued concurrence will be based on the activity's compliance with FCMP authorities, including federal and state monitoring of the activity to ensure its continued conformance, and the adequate resolution of any issues identified during subsequent regulatory reviews. The state's final concurrence of the project's consistency with the FCMP will be determined during the environmental permitting process, in accordance with Section 373.428, *Florida Statutes*.

If you have any questions regarding this message or the state intergovernmental review process, please don't hesitate to contact me at (850) 245-2170 or Lauren.Milligan@dep.state.fl.us. Thank you.

Yours sincerely,

Lauren P. Milligan

Lauren P. Milligan, Coordinator
Florida State Clearinghouse
Florida Department of Environmental Protection
3900 Commonwealth Blvd, M.S. 47
Tallahassee, FL 32399-3000
ph. (850) 245-2170
fax (850) 245-2190
Lauren.Milligan@dep.state.fl.us

From: Pace Wilber - NOAA Federal [mailto:pace.wilber@noaa.gov]
Sent: Thursday, January 16, 2014 8:26 AM
To: Dennis Klemm - NOAA Federal
Cc: CHAMBERS, ANGY L GS-12 USAF AFSPC 45 CES/CEIE; George Getsinger - NOAA Federal; Teletha Mincey - NOAA Federal; Eric Hawk - NOAA Federal
Subject: Re: SpaceX Proposed Return of First Stage to Land

Hello Angy. Same from the EFH perspective. Your consultation requirements for this project have been met and there is no need to re-initiate consultation unless there are project changes that would impact EFH. Please let me know if you have any questions. Pace

On Thu, Jan 16, 2014 at 8:18 AM, Dennis Klemm - NOAA Federal <dennis.klemm@noaa.gov> wrote:
Hello Angy,

As far as the ESA side of the issue there is no need for further consultation. You have already consulted on the aspects that have the potential for impacts to ESA-listed species under NMFS's purview, and as you indicated, the modification would be a "no effect." Federal action agencies do not need to consult with us on, or notify us, of "no effect" determinations.

Thank you,

--
Dennis Klemm
Acting Branch Chief- Interagency Coordination Branch
& Sea Turtle Program Coordinator- Southeast Regional Office
National Marine Fisheries Service
263 13th Avenue South, St. Petersburg, FL 33701
727-551-5777

On Thu, Jan 16, 2014 at 8:09 AM, Teletha Mincey - NOAA Federal <teletha.mincey@noaa.gov> wrote:

---------- Forwarded message ----------
From: **CHAMBERS, ANGY L GS-12 USAF AFSPC 45 CES/CEIE** <angy.chambers@us.af.mil>
Date: Thu, Jan 16, 2014 at 8:07 AM
Subject: SpaceX Proposed Return of First Stage to Land
To: "Pace Wilber - NOAA Federal <pace.wilber@noaa.gov> (pace.wilber@noaa.gov)" <pace.wilber@noaa.gov>, "George Getsinger (George.Getsinger@noaa.gov)" <George.Getsinger@noaa.gov>, "Teletha.Mincey@noaa.gov" <Teletha.Mincey@noaa.gov>, "Eric Hawk (Eric.Hawk@noaa.gov)" <Eric.Hawk@noaa.gov>

Pace et al: SpaceX is proposing to use SLC 36 as a landing site for their first stage. Basically they would launch from SLC 40 and rather than the first stage landing in the ocean, which has previously been consulted on, the first stage would return to land vertically at a previously disturbed site at SLC 36. My question is whether further consultation would be required from your offices since the launch and landing in the ocean has been reviewed/approved and return to land has no effect on marine resources. I appreciate your time and response. Thanks.

v/r

Angy Chambers
Environmental Conservation
45 CES/CEIE
Work 321-853-6822
DSN 467-6822
Cell 321-794-5268

From: Dennis Klemm - NOAA Federal [mailto:dennis.klemm@noaa.gov]
Sent: Thursday, January 16, 2014 8:19 AM
To: CHAMBERS, ANGY L GS-12 USAF AFSPC 45 CES/CEIE
Cc: Pace Wilber - NOAA Federal; George Getsinger - NOAA Federal; Teletha Mincey - NOAA Federal; Eric Hawk - NOAA Federal
Subject: Re: SpaceX Proposed Return of First Stage to Land

Hello Angy,

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<pace.wilber@noaa.gov>, "George Getsinger (George.Getsinger@noaa.gov)"
<George.Getsinger@noaa.gov>, "Teletha.Mincey@noaa.gov" <Teletha.Mincey@noaa.gov>,
"Eric Hawk (Eric.Hawk@noaa.gov)" <Eric.Hawk@noaa.gov>

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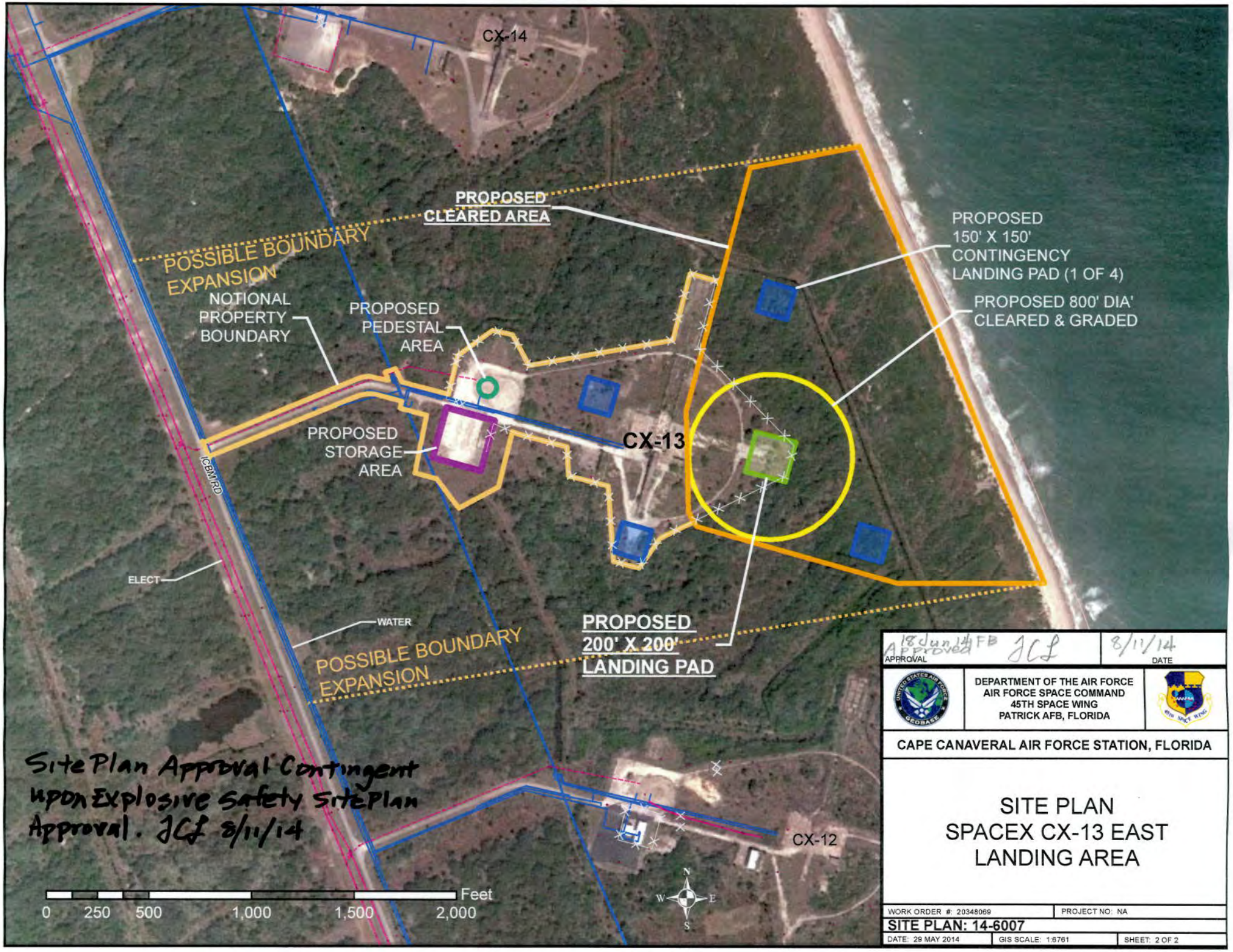
v/r

Angy Chambers
Environmental Conservation
45 CES/CEIE
Work 321-853-6822
DSN 467-6822
Cell 321-794-5268

Appendix B
Draft Site Plan



Site Plan Approval Contingent upon Explosive Safety Site Plan Approval. JCL 8/11/14

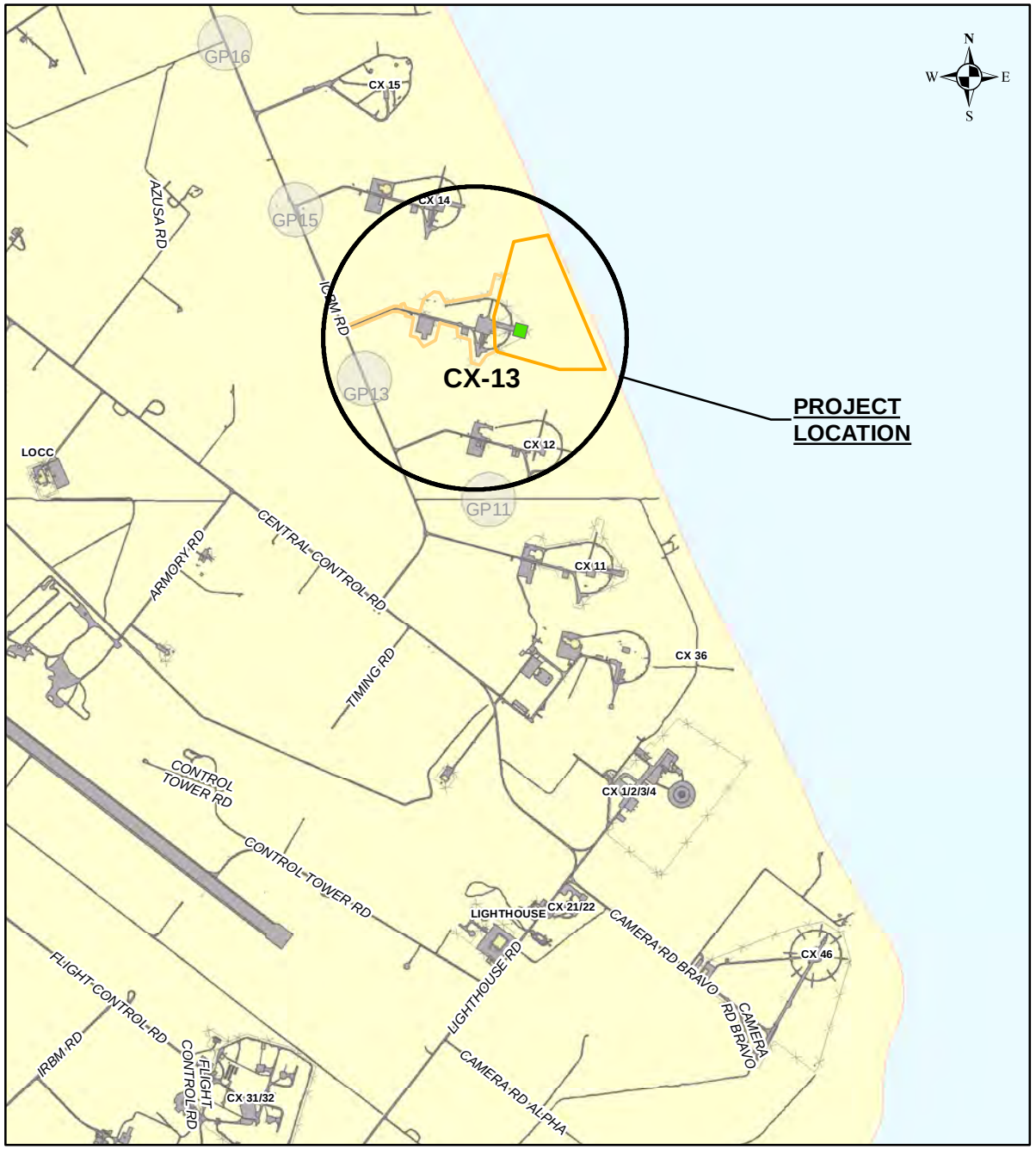
APPROVAL: 18 Jun 14 FB JCL	DATE: 8/11/14

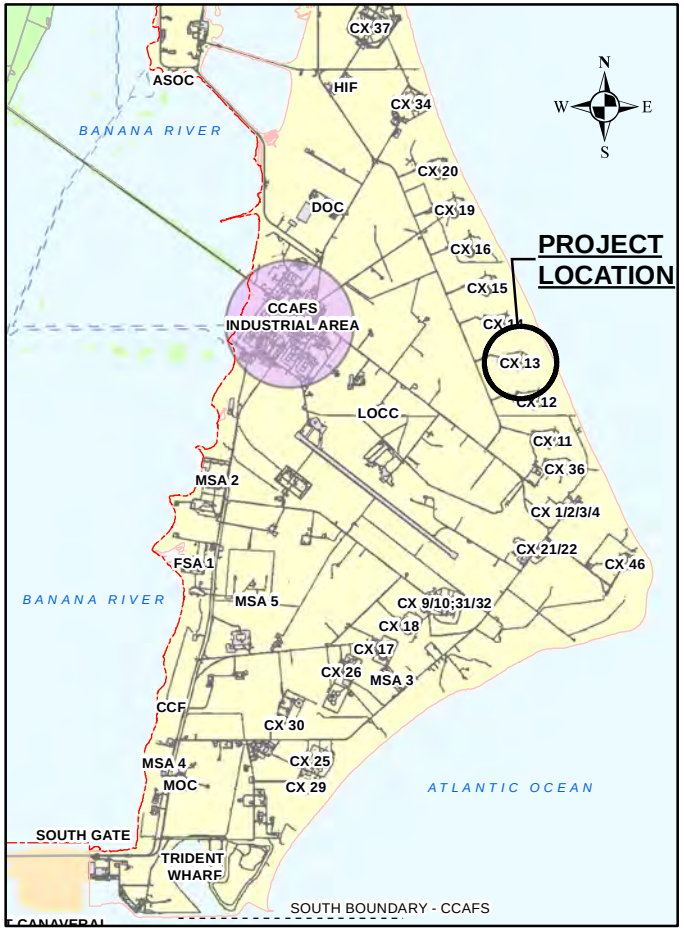
DEPARTMENT OF THE AIR FORCE
AIR FORCE SPACE COMMAND
45TH SPACE WING
PATRICK AFB, FLORIDA

CAPE CANAVERAL AIR FORCE STATION, FLORIDA

SITE PLAN
SPACEX CX-13 EAST LANDING AREA

WORK ORDER #: 20348069	PROJECT NO: NA	
SITE PLAN: 14-6007		
DATE: 28 MAY 2014	GIS SCALE: 1:6761	SHEET: 2 OF 2





DISCLAIMER:
THIS MAP IS PROVIDED FOR INFORMATIONAL PURPOSES ONLY.
GRAPHICALLY, THIS MAP REPRESENTS THE BEST KNOWN CONDITIONS AT THE TIME OF PRINTING. ADDITIONAL SURVEY WORK AND/OR FIELD INVESTIGATION MAY BE REQUIRED PRIOR TO ANY CONSTRUCTION ACTIVITIES AND/OR DIGGING.

3,000 1,500 0 3,000
Feet

DEPARTMENT OF THE AIR FORCE
AIR FORCE SPACE COMMAND
45TH SPACE WING
PATRICK AFB, FLORIDA

CAPE CANAVERAL AIR FORCE STATION, FLORIDA

LOCATION PLAN
SPACEX CX-13 EAST LANDING AREA

WORK ORDER #: 20348069	PROJECT NO: NA	
SITE PLAN: 14-6007		
DATE: 29 MAY 2014	GIS SCALE: NA	SHEET: 1 OF 2

Appendix C
LC-13 (SWMU 038) LUCP and Fact Sheet

Last updated Mar 2013

UNITED STATES AIR FORCE
45TH SPACE WING

Fact Sheet For: SPACE LAUNCH COMPLEX 13, FACILITY 8808, SWMU NO. 038
INSTALLATION RESTORATION PROGRAM– SITE DP004
CAPE CANAVERAL AIR FORCE STATION, FLORIDA

Current Status: **MONITORED NATURAL ATTENUATION (WITH ADDITIONAL ENHANCEMENT, IF APPROPRIATE); MANAGEMENT OF LAND USE CONTROLS**

Site History: Solid Waste Management Unit (SWMU) No. 038, abandoned Space Launch Complex 13 (SLC-13), is located on the eastern side of Cape Canaveral Air Force Station (CCAFS) adjacent to the Atlantic Ocean (see site map, below). SLC-13 was constructed in 1956 for the Atlas Missile Program. As an active launch complex, a number of hazardous chemicals were stored and used on-site, including solvents, petroleum compounds, and other hazardous materials. It is suspected that materials used at this site such as rocket fuel and solvents may have been disposed of on site. It has also been established that historical paint formulations used on launch structures included polychlorinated biphenyls (PCBs) and lead. Routine sand blasting activities following launches dispersed the PCBs throughout site surface soils. SLC-13 was officially de-activated in 1978, but launch structures were left in place. The historical coatings were never removed or otherwise mitigated, and continued corrosion spread PCB and lead contamination throughout the site.

Environmental Media and Contaminants:

Groundwater: Contaminants identified in groundwater at the site include chlorinated solvent residuals.

Surface Water: No contaminants were detected in surface water at concentrations that pose a risk to human health or the environment.

Sediment: An Interim Measure (IM) was conducted in order to remove metals-contaminated sediments and soils from the deluge basin at SLC-13. No additional sediment concerns exist at the site.

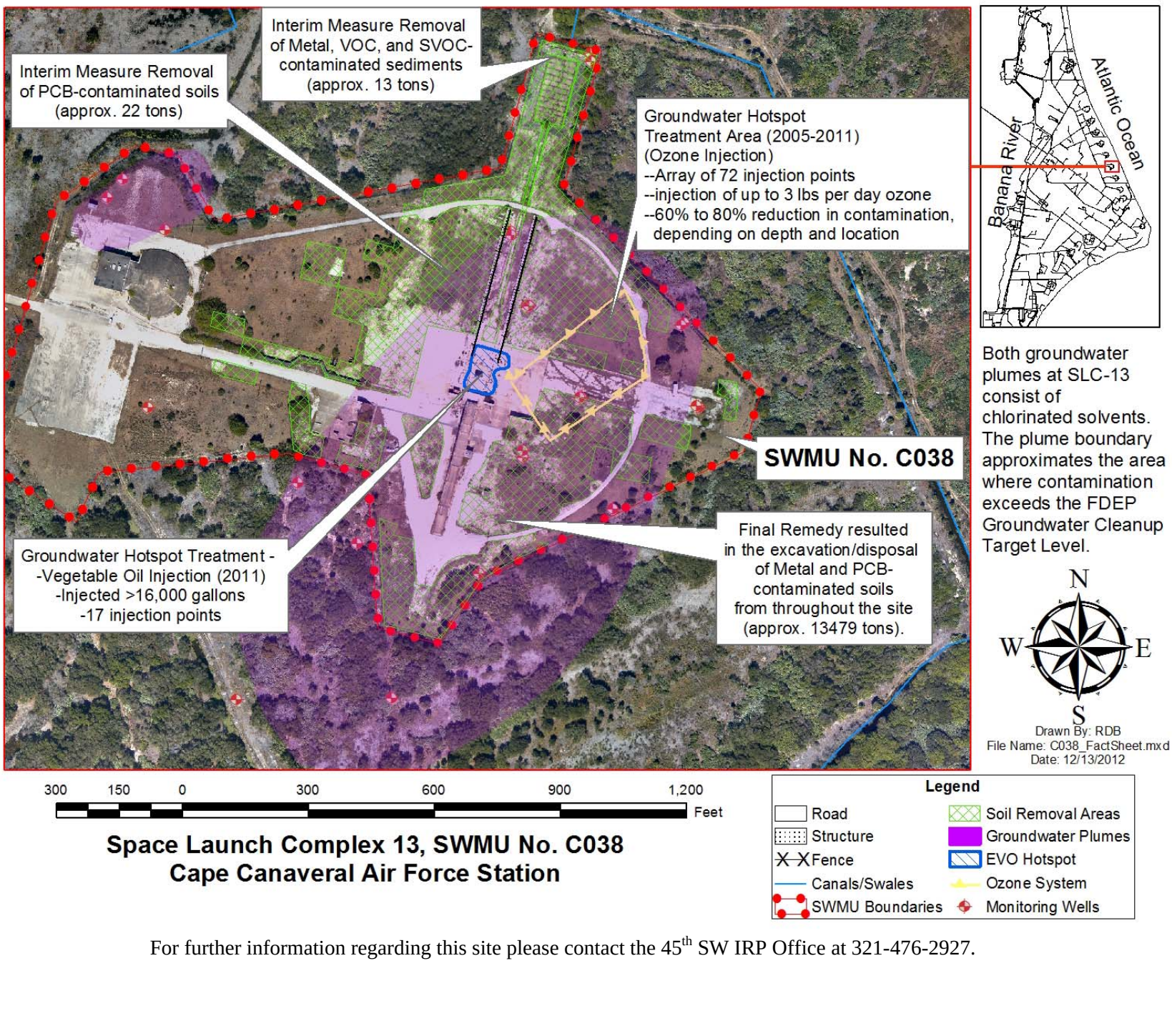
Soil: Contaminants identified in site soil include metals, PCBs, and polynuclear aromatic hydrocarbons (PAHs). In the 1990s, an IM was conducted to excavate and remove the most contaminated soils. In 2005, the final remedy included removal of the remaining structures coated with PCB and lead-laden paints, followed by a soil cleanup. Following this action, remaining soils throughout most of the site are safe under all land use scenarios. Areas around the flume trench, deluge basin, and blockhouse are limited to industrial re-use due to residual PCB, metal, and PAH contamination that exceeds residential cleanup requirements.

Current Status: In accordance with the U.S. Environmental Protection Agency's Resource Conservation and Recovery Act (RCRA), a Preliminary Assessment (PA) was completed in 1992 and concluded that sampling was warranted at the site. A Site Investigation (SI) was conducted from 1994 to 1997. Based on the PA and SI, a RCRA Facility Investigation (RFI) was the conducted to evaluate the nature and extent of contamination at the site and to assess the human health and ecological risk posed by site contaminants. During these investigations, two separate IMs were implemented to excavate contaminated soil and sediment. The first IM addressed contaminated sediments in the deluge basin, while the second IM targeted areas with the highest concentrations of soil contamination. Since the PCB and lead-based paint on the derelict launch stand was a continuing source of soil contamination, it was determined that a complete soil cleanup would be delayed until the source could be properly mitigated. The RFI, completed in 2002, recommended a Corrective Measures Study (CMS) to assess potential remedies for groundwater contamination, the continuing source of PCBs at the site, and remaining PCB-contaminated soils. Two separate CMS reports were completed.

The Statement of Basis for both remedies was finalized and released for public review during August 2005. Ozone injection was identified as the selected groundwater remedy. An ozone treatment system was installed in 2005 and was operated until 2011, when an approximately 80% reduction was documented in the treatment area. The PCB-paint laden structures were demolished in 2005 and disposed of in accordance with PCB waste regulations. Subsequently, remaining contaminated soils from throughout the site were excavated and disposed. Residual soil contamination in the area of the deluge basin, flume trench and blockhouse limits site re-use to industrial scenarios.

Additional groundwater sampling was performed in 2010 to assess areas where access was previously restricted by safety concerns. In 2011, vegetable oil was injected in a hotspot that was identified outside the ozone treatment footprint. In 2012, more groundwater sampling was performed to completely delineate any remaining groundwater "hotspots" and to prepare a fate and transport model to assist with determining additional treatment that might accelerate the overall time to cleanup. Plume-wide monitored natural attenuation (MNA) has been on-going throughout all treatment actions.

Future Actions: Remaining soils are safe under all but residential land use scenarios. Land use controls have been implemented to ensure industrial re-use in the impacted areas. Currently, MNA is on-going to assess the continued natural degradation of residual groundwater contamination. Land use controls will be maintained on both soil and groundwater to ensure that contaminant residuals do not cause any adverse impacts to human health or the environment. LTM and LUCs will continue until residual contamination is removed or naturally attenuates to acceptable regulatory levels. Additional treatment or enhancements, like the 2011 vegetable oil injection, may help accelerate groundwater cleanup.

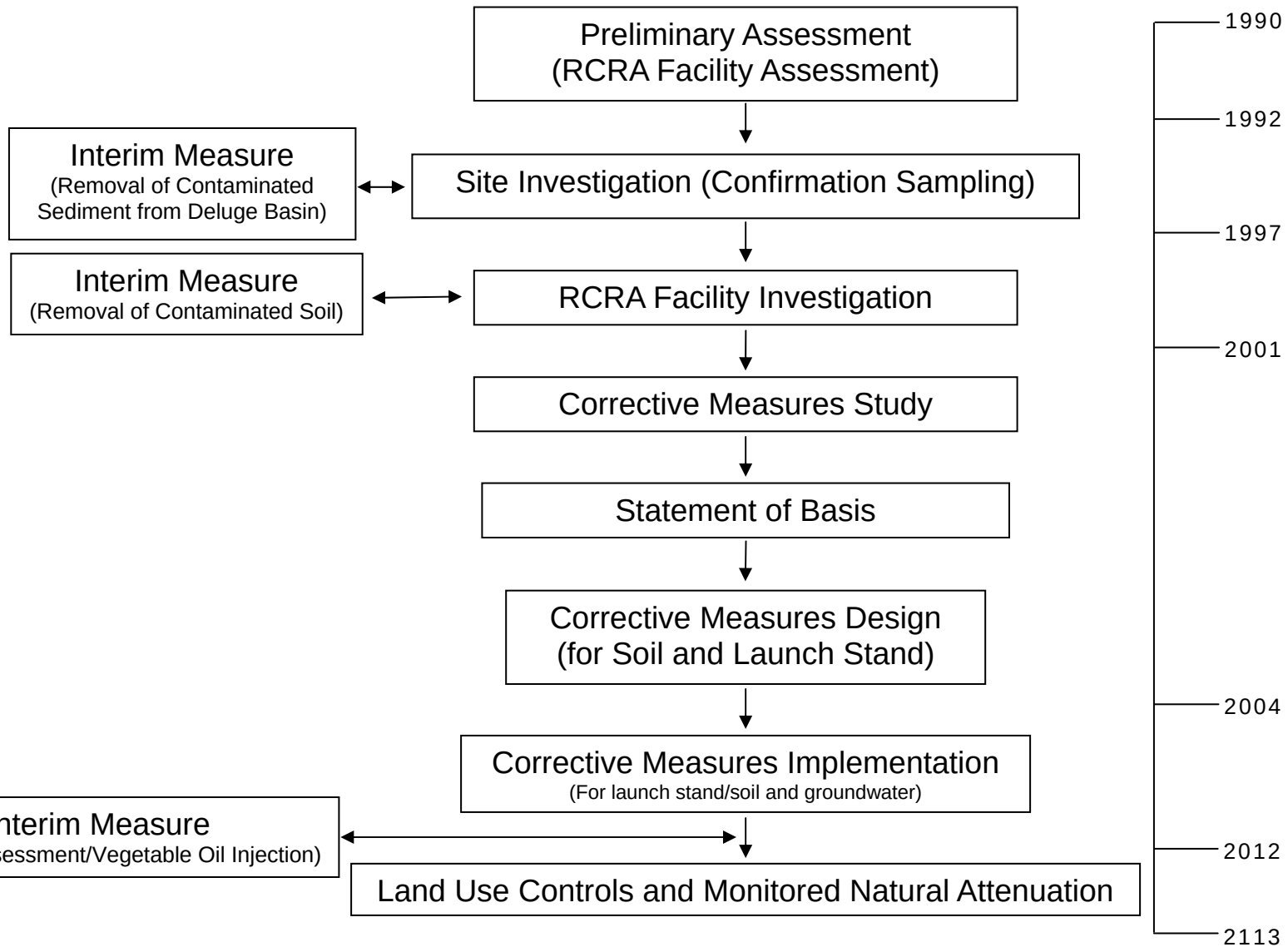


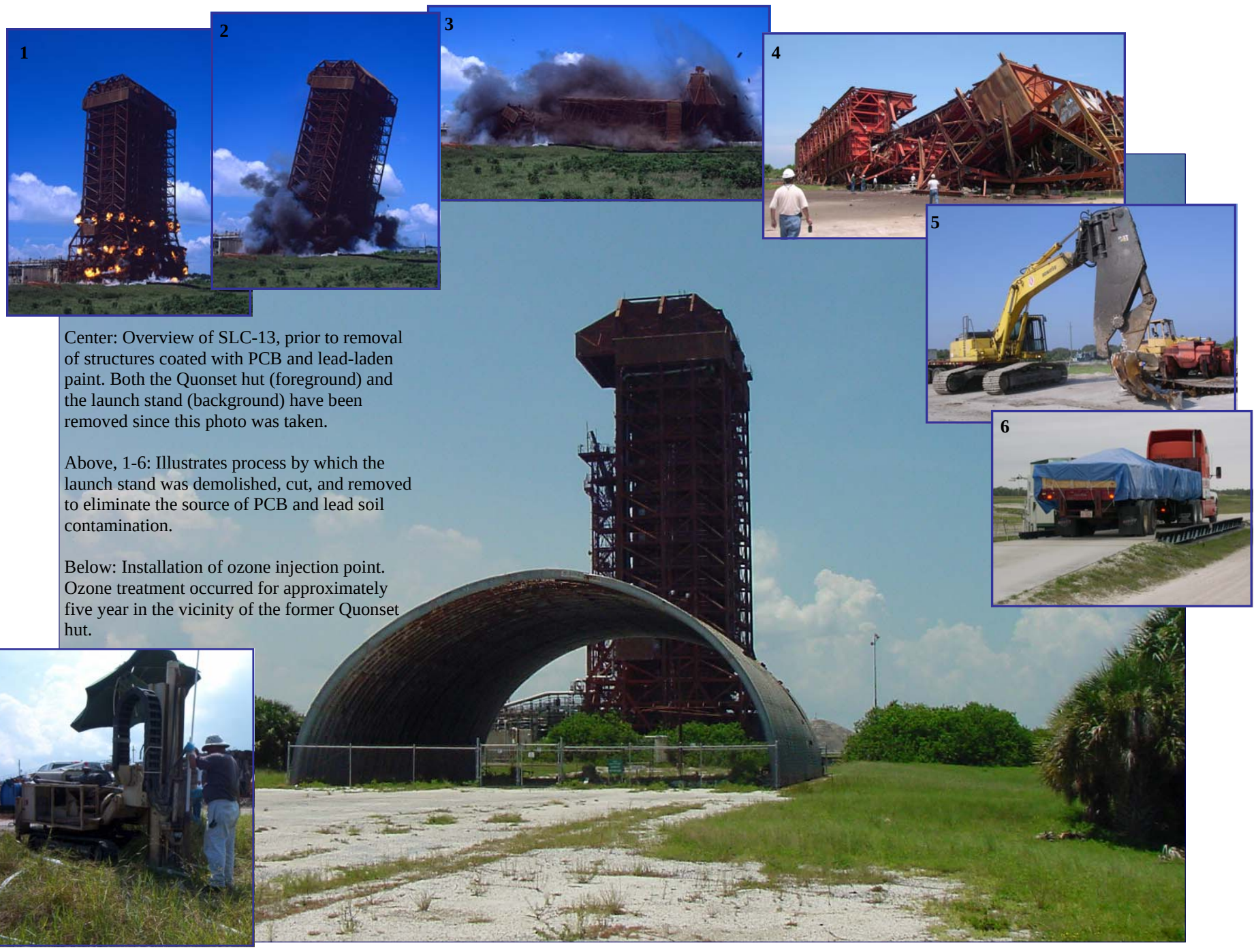
Space Launch Complex 13, SWMU No. C038
Cape Canaveral Air Force Station

For further information regarding this site please contact the 45th SW IRP Office at 321-476-2927.

IRP Process Flow Chart

SWMU No. 038 (Space Launch Complex 13, CCAFS)





Center: Overview of SLC-13, prior to removal of structures coated with PCB and lead-laden paint. Both the Quonset hut (foreground) and the launch stand (background) have been removed since this photo was taken.

Above, 1-6: Illustrates process by which the launch stand was demolished, cut, and removed to eliminate the source of PCB and lead soil contamination.

Below: Installation of ozone injection point. Ozone treatment occurred for approximately five year in the vicinity of the former Quonset hut.

For further information regarding this site please contact the 45th SW IRP Office at 321-476-2927

LAND USE CONTROL IMPLEMENTATION PLAN

SPACE LAUNCH COMPLEX 13
SOLID WASTE MANAGEMENT UNIT 038 (SWMU NO. 038)
45TH SPACE WING
CAPE CANAVERAL AIR FORCE STATION
BREVARD COUNTY, FLORIDA

Facility Description
Solid Waste Management Unit (SWMU) No. 038, abandoned Space Launch Complex 13 (SLC-13), is located on the eastern side of Cape Canaveral Air Force Station (CCAFS) adjacent to the Atlantic Ocean (see site map, below). Portions of this site served as an active non-hazardous waste drum storage area and a nitrogen and helium storage area. It is suspected that materials used at this site such as rocket fuel and solvents may have been disposed of on-site.

Location (Reference Site Map on last page of this document)

Site Plan Coordinate	Northing	Easting
North	1510416.69	802620.63
West	1509408.25	801314.61
South	1508110.50	801694.85
East	1509565.30	803157.91

Objective
Implementation of site-specific land use controls to protect against exposure to contaminated soil and shallow groundwater and to prevent consumption of the shallow groundwater.

Land Use Controls (LUCs) to be Implemented:
Administrative:

- The property will be prohibited from residential or other non-industrial development without prior written notification to the Florida Department of Environmental Protection (FDEP) and the United States Environmental Protection Agency (USEPA) concerning the SWMU land use change. Dependent on site conditions and the nature and intensity of the proposed land use change, additional site investigations and assessments could be required for the United States Air Force (USAF). Based on these analyses, additional remedial measures may be required prior to land use change.

Please contact the 45 SW Installation Restoration Program Office to obtain additional information, including:
the 45 SW Land Use Controls Management Plan; the CCAFS HSWA Permit; a complete record of corrective actions at SLC-13; or other related documents, guidance, and regulations. The IRP office can be reached by phone at (321) 853-0965. Information can also be obtained via the IRP website at http://www.mission-support.org/45SW_IRP_EA

- Perform and document baseline LUC audit upon finalization of the Statement of Basis.
- Perform and document quarterly LUC compliance inspections in accordance with 45th SW LUC Management Plan.
- Perform, document, and report an annual audit on LUC implementation, maintenance, and compliance in accordance with the 45th SW LUC Management Plan and the current CCAFS Corrective Action Management Plan (CAMP).
- The property Land Use Control Implementation Plan (LUCIP) shall remain in effect until:
  a) Changes to applicable Federal and State risk-based clean-up standards occur which indicate site contaminants no longer pose potential residential risk; or
  b) Reduction in site contaminant concentrations to below Federal and State residential risk-based clean-up standards occurs.
- In the event of property realignment, transfer, or re-use for non-industrial or non-commercial purposes, assessment and remediation may be necessary to ensure that impacts to ecological receptors are not increased or to mitigate potential ecological impacts where residual contamination exists.

Soil:

- Soils will not be disturbed or moved during property development, maintenance or construction, without:
  a) USAF review, coordination, and approval of the proposed construction/ development plans via AF Form 103 (Base Civil Engineer Work Clearance Request), 332 (Base Civil Engineer Work Request), 813 (Request for Environmental Impact Analysis), or similar process;
  b) Ensuring proper engineering controls are in-place so that unauthorized release or disposal of the affected media does not occur. This includes conducting appropriate testing and developing a disposal plan in accordance with the LUC Management Plan prior to off-site disposal; and
  c) Use of proper personal protection equipment by site workers, as determined by the project proponent's occupational health and safety advisor.
- The site will be posted with proper warning signs in accordance with the LUC Management Plan and the CCAFS Hazardous and Solid Waste Amendments (HSWA) Permit.

Groundwater:

- The consumptive use of the site's surficial aquifer groundwater will be prohibited.
- Incidental consumption and dermal exposure to groundwater from the surficial aquifer will be prevented. This will be addressed by the project proponent's health and safety advisor.
- Groundwater will not be contacted, pumped, or discharged during property development, maintenance, or construction, without:
  a) USAF review, coordination, and approval of the proposed construction/

development plans via AF Form 103 (Base Civil Engineer Work Clearance Request), 332 (Base Civil Engineer Work Request), 813 (Request for Environmental Impact Analysis), or similar process;

b) Ensuring proper engineering controls are in-place so that unauthorized release or disposal of the affected media (groundwater) does not occur. This includes conducting appropriate testing and developing a disposal plan in accordance with the LUC Management Plan prior to any pumping or discharge of groundwater; and

c) Use of proper personal protection equipment by site workers, as determined by the project proponent's occupational health and safety advisor.

- USAF will institute a long term monitoring (LTM) program of groundwater in the surficial aquifer in accordance with an approved LTM work plan and the CAMP as part of the CCAFS HSWA Permit. Reports will be submitted annually, along with revised work plan recommendations, until such a time as the relevant regulatory agencies agree that contaminant concentrations in groundwater no longer warrant LTM.
- The site will be posted with proper warning signs in accordance with the LUC Management Plan and the CCAFS HSWA permit.

Statement of Basis:
The Statement of Basis (SB) has been approved. The remedy was incorporated in the October 2005 HSWA Permit modification.

Additional Information:
Pertinent Document Reference:

Statement of Basis, URS Corp, April 2005.

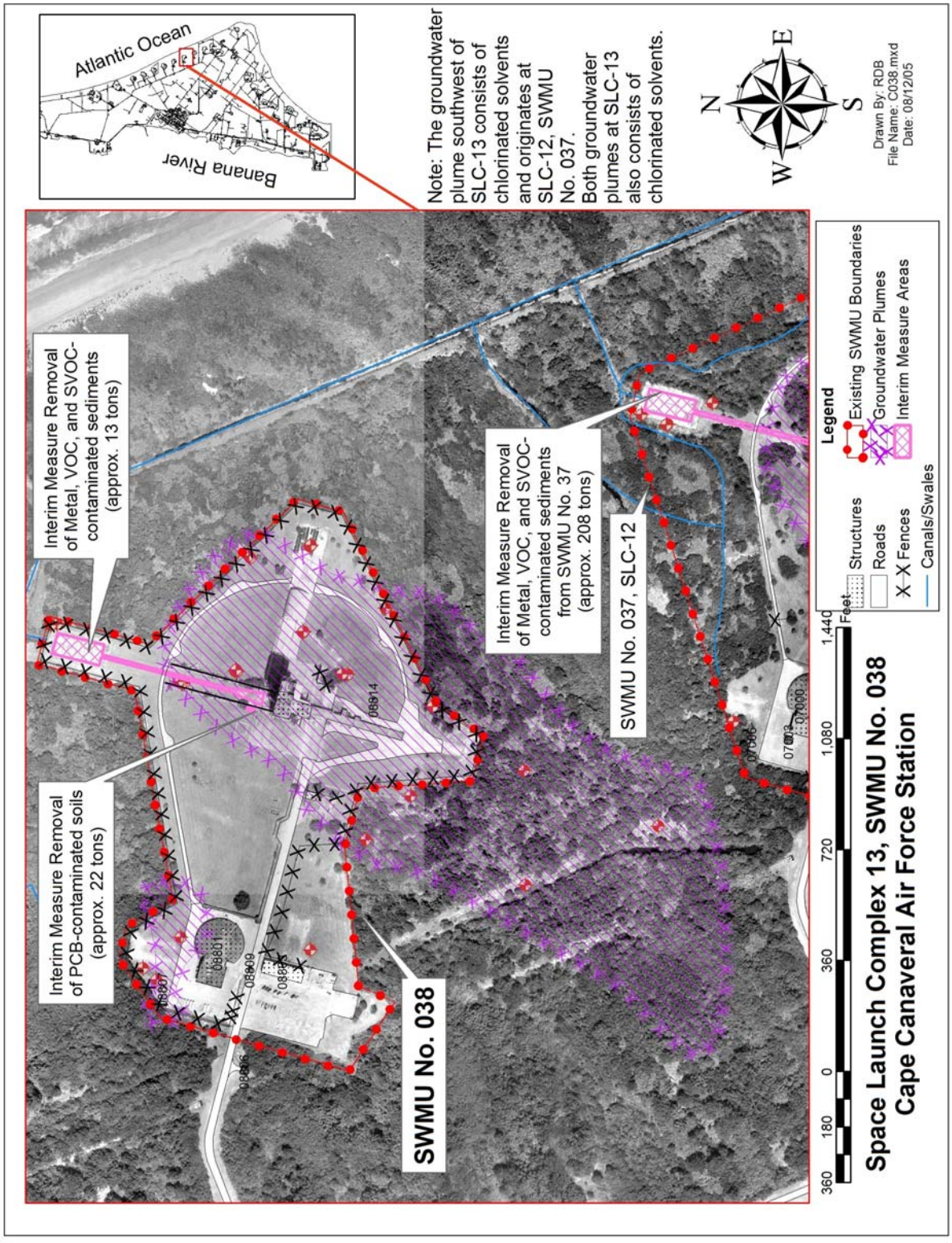
Final Corrective Measures Study for Launch Tower, URS Corp, December 2003.

Corrective Measures Study for Groundwater, Rev. 0, Apex Environmental, November 2003.

RCRA Facility Investigation Report, O'Brien & Gere Engineers, Inc., November 2001.

PCB Soil Removal Interim Measure Report, BEM Systems, July 1999

Space Launch Complex 13 – Site Map



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Appendix D
Brevard County, Florida Soils Map

United States Department of Agriculture

NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for Brevard County, Florida

May 8, 2014

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (http://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means

for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination, write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410 or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.

Contents

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the

individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Custom Soil Resource Report
Soil Map

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Brevard County, Florida
Survey Area Data: Version 11, Dec 6, 2013

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Mar 12, 2011—Mar 13, 2011

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Brevard County, Florida (FL009)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
9	Canaveral-Anclote complex, gently undulating	77.4	75.6%
10	Canaveral-Urban land complex	11.5	11.2%
14	Beaches	0.2	0.2%
69	Urban land	13.3	13.0%
Totals for Area of Interest		**102.3**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments

on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Brevard County, Florida

9—Canaveral-Anclote complex, gently undulating

Map Unit Setting

Elevation: 10 to 60 feet
Mean annual precipitation: 49 to 57 inches
Mean annual air temperature: 68 to 75 degrees F
Frost-free period: 350 to 365 days

Map Unit Composition

Canaveral and similar soils: 60 percent
Anclote and similar soils: 30 percent
Minor components: 10 percent

Description of Canaveral

Setting

Landform: Dunes on marine terraces, ridges on marine terraces
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Sandy marine deposits

Properties and qualities

Slope: 0 to 5 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Very high (19.98 to 50.02 in/hr)
Depth to water table: About 12 to 36 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 15 percent
Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum: 6.0
Available water capacity: Very low (about 1.4 inches)

Interpretive groups

Farmland classification: Not prime farmland
Land capability (nonirrigated): 6s
Hydrologic Soil Group: A/D
Other vegetative classification: Forage suitability group not assigned (G156BC999FL)

Typical profile

0 to 6 inches: Sand
6 to 12 inches: Sand
12 to 80 inches: Coarse sand

Description of Anclote

Setting

Landform: Flats on marine terraces
Landform position (three-dimensional): Talf
Down-slope shape: Linear

Across-slope shape: Linear
Parent material: Sandy marine deposits

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Very poorly drained
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: About 0 to 6 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum: 4.0
Available water capacity: Low (about 5.3 inches)

Interpretive groups

Farmland classification: Not prime farmland
Land capability (nonirrigated): 3w
Hydrologic Soil Group: A/D
Other vegetative classification: Sandy soils on flats of mesic or hydric lowlands (G156BC141FL)

Typical profile

0 to 19 inches: Sand
19 to 72 inches: Sand

Minor Components

Palm beach

Percent of map unit: 5 percent
Landform: Dunes on marine terraces
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Linear
Other vegetative classification: Sandy soils on ridges and dunes of xeric uplands (G156BC111FL)

Pomello

Percent of map unit: 5 percent
Landform: Flats on marine terraces, rises on marine terraces
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Linear
Ecological site: Sand Pine Scrub (R155XY001FL)
Other vegetative classification: Sandy soils on rises and knolls of mesic uplands (G156BC131FL)

10—Canaveral-Urban land complex

Map Unit Setting

Elevation: 10 to 100 feet
Mean annual precipitation: 49 to 57 inches
Mean annual air temperature: 68 to 75 degrees F
Frost-free period: 350 to 365 days

Map Unit Composition

Canaveral and similar soils: 50 percent
Urban land: 40 percent
Minor components: 10 percent

Description of Canaveral

Setting

Landform: Flats on marine terraces, ridges on marine terraces
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Sandy marine deposits

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Moderately well drained
Capacity of the most limiting layer to transmit water (Ksat): Very high (19.98 to 50.02 in/hr)
Depth to water table: About 30 to 60 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 15 percent
Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum: 6.0
Available water capacity: Very low (about 1.4 inches)

Interpretive groups

Farmland classification: Not prime farmland
Land capability (nonirrigated): 6s
Hydrologic Soil Group: A
Other vegetative classification: Forage suitability group not assigned (G156BC999FL)

Typical profile

0 to 6 inches: Sand
6 to 12 inches: Sand
12 to 80 inches: Coarse sand

Description of Urban Land

Setting

Landform: Marine terraces
Landform position (three-dimensional): Interfluve, talf
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: No parent material

Interpretive groups

Farmland classification: Not prime farmland
Other vegetative classification: Forage suitability group not assigned (G156BC999FL)

Minor Components

Anclote

Percent of map unit: 4 percent
Landform: — error in exists on —
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear
Other vegetative classification: Forage suitability group not assigned (G156BC999FL)

Pompano

Percent of map unit: 3 percent
Landform: Flats on marine terraces
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: Slough (R155XY011FL)
Other vegetative classification: Forage suitability group not assigned (G156BC999FL)

Myakka

Percent of map unit: 3 percent
Landform: Flats on marine terraces
Landform position (three-dimensional): Talf
Down-slope shape: Convex
Across-slope shape: Linear
Ecological site: South Florida Flatwoods (R155XY003FL)
Other vegetative classification: Forage suitability group not assigned (G156BC999FL)

14—Beaches

Map Unit Setting

Elevation: 0 to 20 feet

Mean annual precipitation: 42 to 57 inches
Mean annual air temperature: 52 to 75 degrees F
Frost-free period: 190 to 365 days

Map Unit Composition
Beaches: 95 percent
Minor components: 5 percent

Description of Beaches

Setting
Landform: Beaches on marine terraces
Landform position (three-dimensional): Rise
Down-slope shape: Convex
Across-slope shape: Linear

Interpretive groups
Farmland classification: Not prime farmland
Land capability (nonirrigated): 8
Other vegetative classification: Forage suitability group not assigned (G133AA999FL)

Minor Components

Palm beach
Percent of map unit: 3 percent
Landform: Dunes on marine terraces
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Linear
Other vegetative classification: Sandy soils on ridges and dunes of xeric uplands (G156BC111FL)

Canaveral
Percent of map unit: 2 percent
Landform: Flats on marine terraces, ridges on marine terraces
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Linear
Other vegetative classification: Forage suitability group not assigned (G156BC999FL)

69—Urban land

Map Unit Composition
Urban land: 100 percent

Description of Urban Land

Setting
Landform: Marine terraces

Landform position (three-dimensional): Interfluve, talf
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: No parent material

Interpretive groups

Farmland classification: Not prime farmland
Other vegetative classification: Forage suitability group not assigned (G156BC999FL)

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Appendix E
SpaceX F9R Acoustic Test Study and Sonic Boom Model

DNL ACOUSTIC LANDING PREDICTIONS

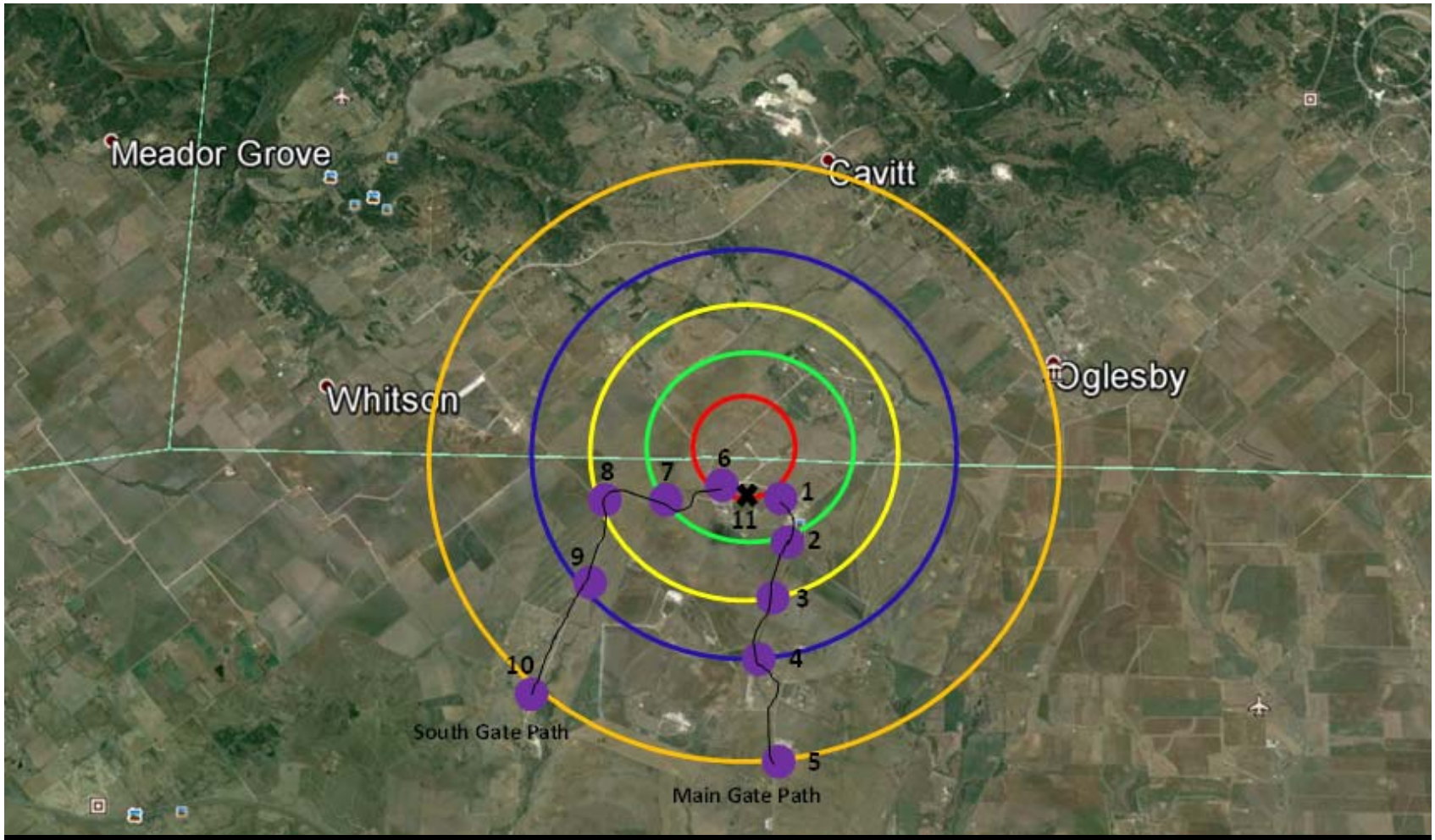
LC-13 Environmental Assessment

SPACEX

Summary

- **Approach:**
  - Collect data during F9-R testing at McGregor, Texas at various locations
    - ExTech Sound Level Datalogger
      - Frequency weighted to an A
      - Measures the OASPL from 31.5 to 8000 Hz
  - Developed a predicted trend equation to determine how the acoustics propagate based on the dBA data obtained during F9R test flights
  - Provide a conservative approximation for 3000 re-entry

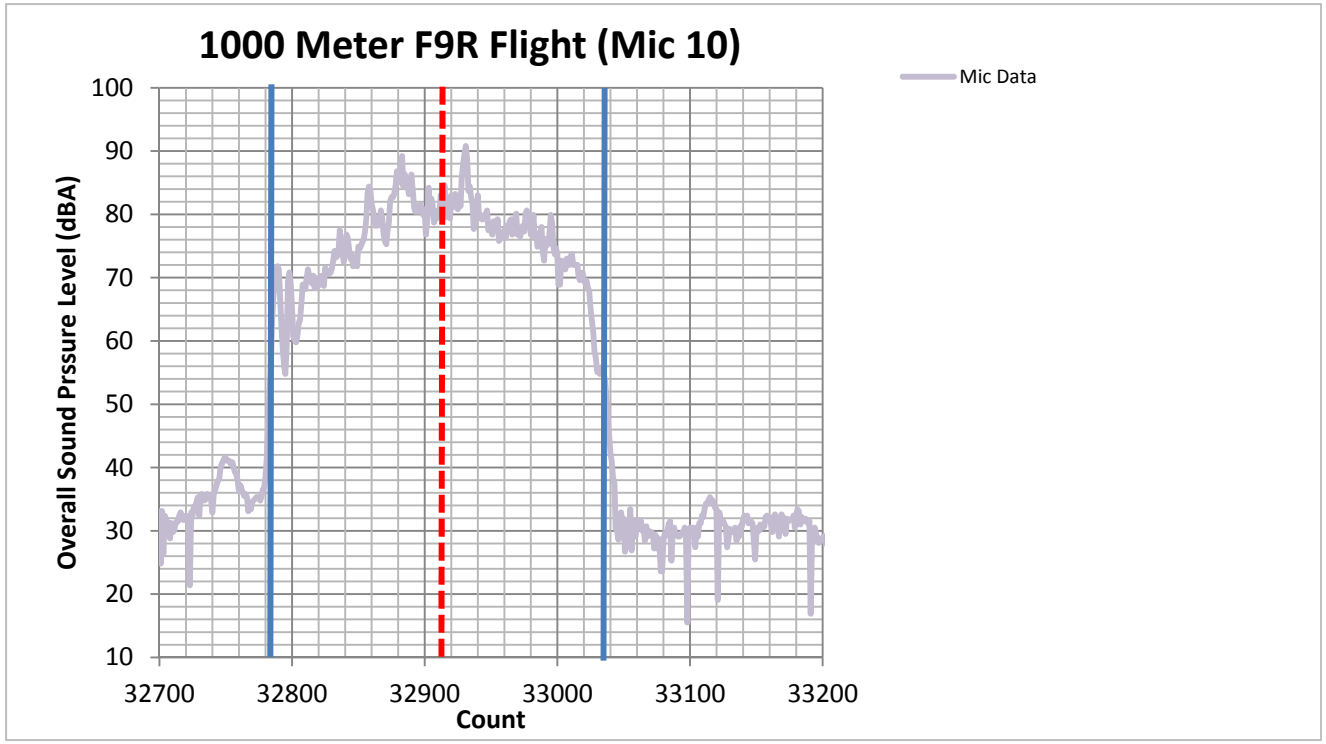
Microphone Location



The same set-up was used for both the 250 meter flight and the 1000 meter flight.
(\\filer1\Dynamics\GSanchez\Analysis\Acoustics\Far Field Launch Acoustics\Microphone_Set-up\F9R TX Far-Field Acoustics.pptx)

Collecting Microphone Data

- For each microphone, the following data was collected for the two 1000 meter flights
  - Average OASPL during re-entry (dBA)
  - Sound exposure level during re-entry (SEL)
- To insure that the correct time segment was analyzed, each microphone was carefully looked at to determine the start-up, start of re-entry, and shut down times for each flight event



Post Processing the data

- Analysis
  - Developed a predicted trend equation to determine how the acoustics propagate based on the average value obtained during flight.
  - Determine the sound exposure level for all the data collected from the 1000 meter flight
  - Conduct a conservative approximation of a 3000 meter flight
- All data is collected or post processed in dBA
- Assuming an average sound exposure level of 65dBA for days that we are not firing

Calculating the Day-Night Sound Level

$$Ldn = 10log10\left[\frac{1}{86400 * \mathbf{2}}\left(\int_{0}^{700} 10^{L_A(t)+10/10}dt + \int_{700}^{2200} 10^{L_A(t)/10}dt + \int_{2200}^{2400} 10^{L_A(t)+10/10}dt\right)\right]$$

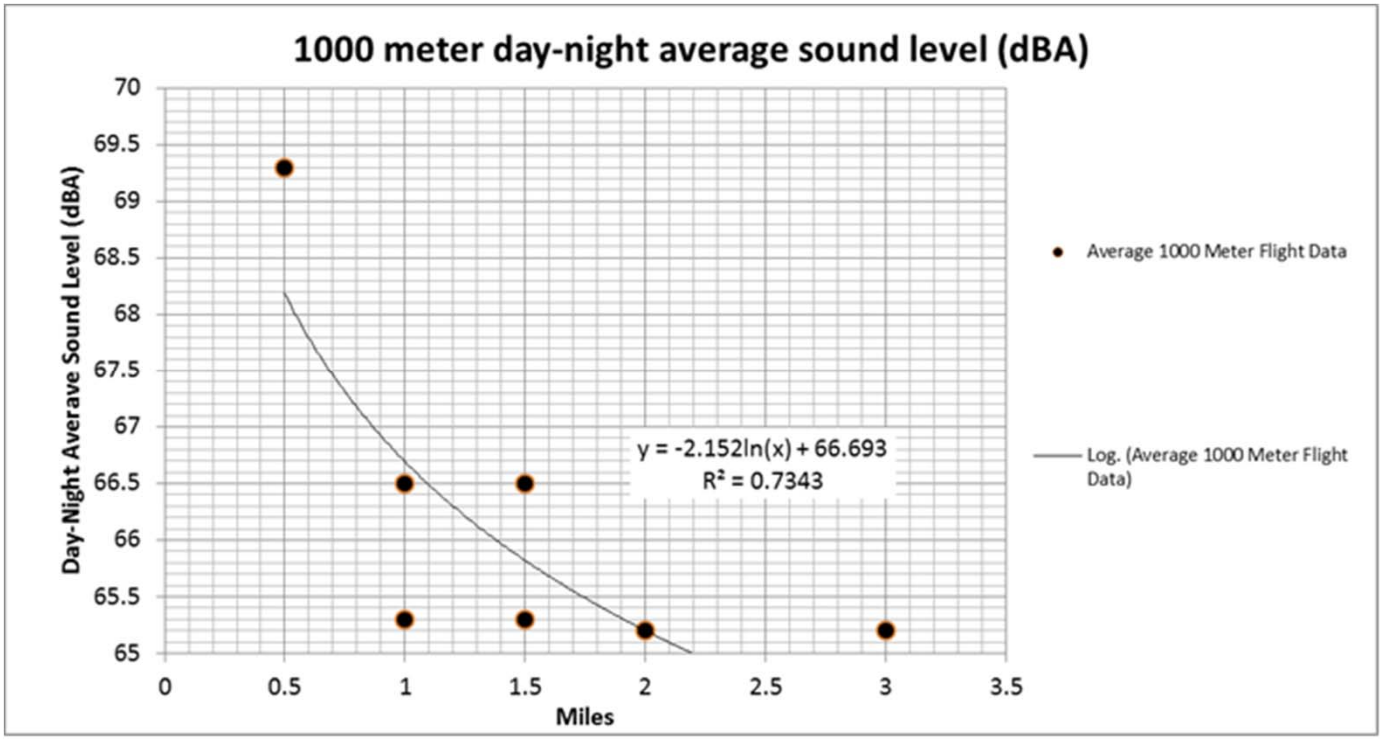
$$Yearly\ Ldn = 10log10\left(\frac{1}{365}\right)\sum_{i=1}^{365} 10^{Ldn_i/10}$$

- The SEL level for non flight days will be 65 dBA
- Assume that the L_A value for non flight duration will also be considered to be 65dBA
- We will assume 12 flights per year and one night flight
- The 1000 meter flight 2 re-entry duration lasted for 120 seconds while the 1000 meter flight 3 re-entry duration latest for 117 seconds, but will be round to 120 seconds
- The conservative 3000 meter flight will last for 360 seconds
  - 0 to 1000 meters
    - The data will be exactly the same as the 1000 meter flights
    - This event will last for 120 seconds
  - 1000 to 3000 meters
    - This event will last for 240 seconds
    - The dBA value for the entire duration will be the maximum value collected from the maximum reading from the 1000 meter microphones

Since the data is recorded in increments of .5 seconds, the 2 from the equation is taking this into account

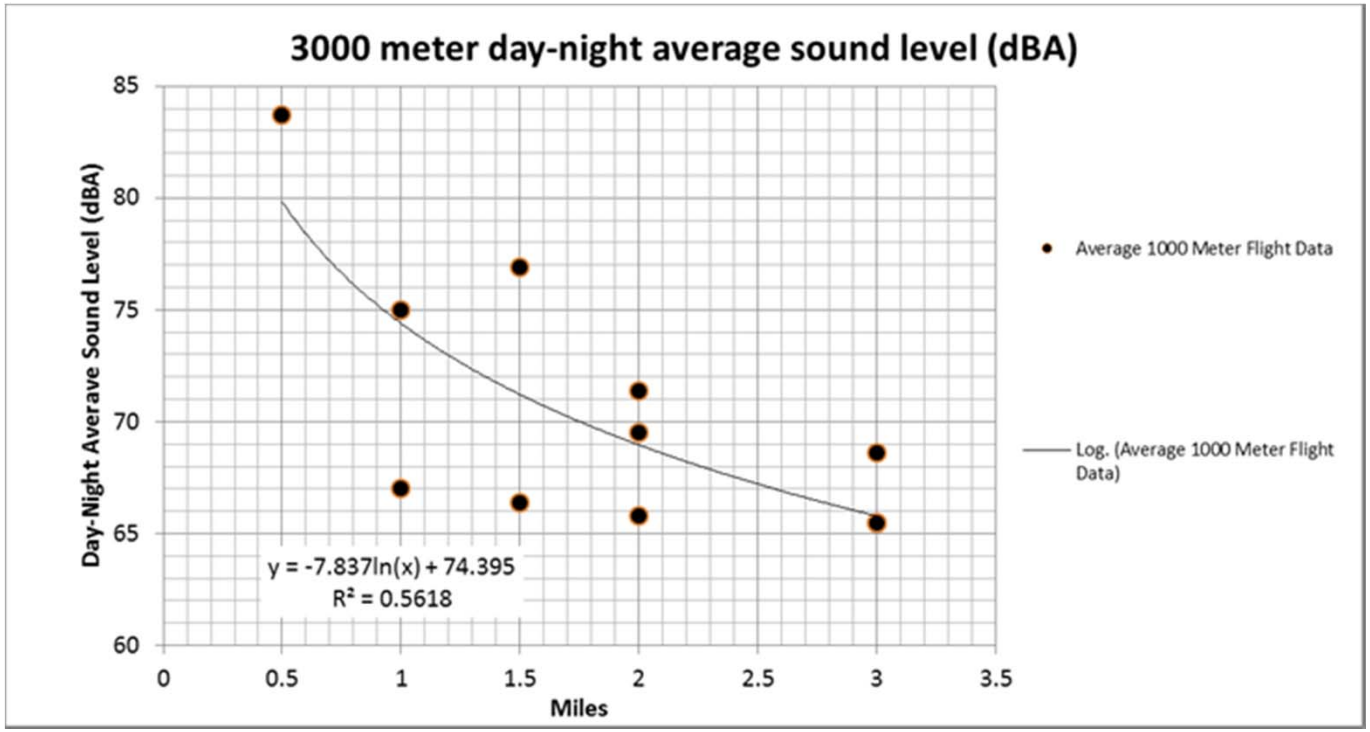
1000 Meter Yearly DNL

- Data collected during two 1000 meter flights
- Data that was corrupted for microphones was removed
- This data assumes that 9 flights will be during the day time while 3 flights will be during the night
- This is assuming a logarithmic trend



3000 Meter Yearly DNL

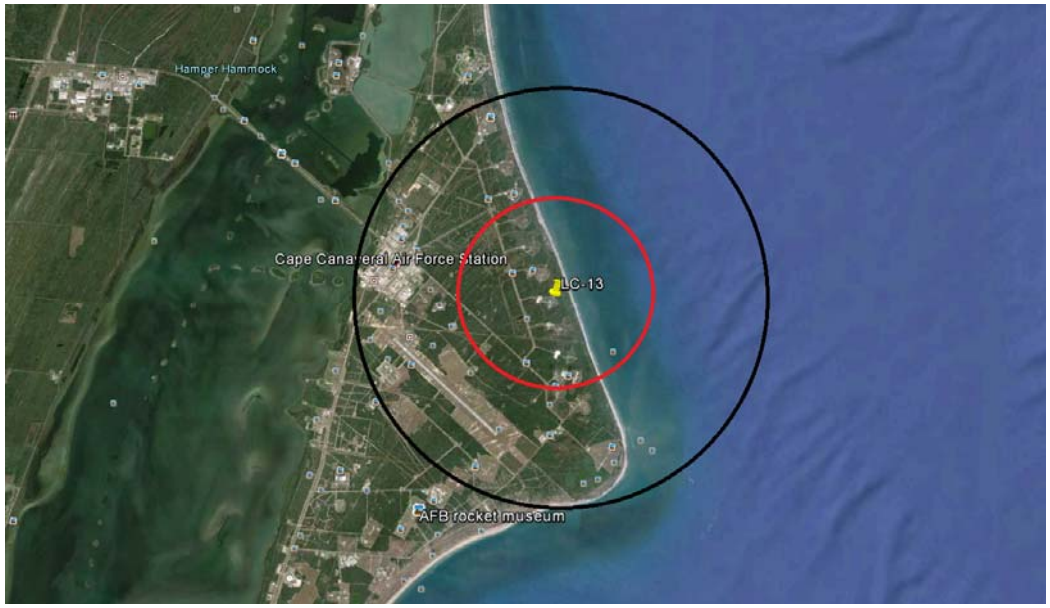
- Data collected during two 1000 meter flights
- Data that was corrupted for microphones was removed
- This data assumes that 9 flights will be during the day time while 3 flights will be during the night
- This is assuming a logarithmic trend



Using the dBA Data From 1000 Meter Flight

- Anything within the red circle will experience roughly a day/night average sound level of 1.5dBA increase with the 1000 meter data
- Anything within the black circle will experience roughly a day/night average sound level of 1.5dBA increase with the 3000 meter assumption

Cape Canaveral



RED Circle = 1.1 Miles **Black Circle = 2.7 Miles**

Sonic Boom Assessment of Falcon 9 Landing at Cape Canaveral Air Force Station

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Table of Contents

Figures

1.0 Introduction

The sonic boom footprint has been computed for the Falcon 9 launch vehicle during the entry and descent of the reusable first stage to Cape Canaveral Air Force Station.

Sonic boom is generated while the Falcon 9 is supersonic during descent, above an altitude of about 30000 feet. Sonic boom analysis was performed with Wyle's PCBoom software.[1,2] Section 2 presents a background discussion of sonic boom. Section 3 presents the results for Falcon 9 descent.

2.0 Sonic Boom Background

A sonic boom is the wave field about a supersonic vehicle. As the vehicle moves, it pushes the air aside. Because flight speed is faster than the speed of sound, the pressure waves can't move away from the vehicle, as they would for subsonic flight, but stay together in a coherent wave pattern. The waves travel with the vehicle. Figure 1 is a classic sketch of sonic boom from an aircraft in level flight. It shows a conical wave moving with the aircraft, much like the bow wave of a boat. While Figure 1 shows the wave as a simple cone, whose ground intercept extends indefinitely, temperature gradients in the atmosphere generally distort the wave from a perfect cone to one that refracts upward, so the ground intercept goes out to a finite distance on either side. Boom is not a one time event as the aircraft "breaks the sound barrier" but is often described as being swept out along a "carpet" across the width of the ground intercepts and the length of the flight track. Booms from steady or near-steady flight are referred to as carpet booms.

The waveform at the ground is generally an "N-wave" pressure signature, as sketched in the figure, where compression in the forward part of the vehicle and expansion and recompression at the rear coalesce into a bow shock and a tail shock, respectively, with a linear expansion between.

Figure 1 is drawn from the perspective of aircraft coordinates. The wave cone exists as shown at a particular time, but is generated over a time period. Booms can also be viewed from the perspective of rays propagating relative to ground-fixed coordinates. Figure 2 shows both perspectives. The cone represents rays that are generated at a given time, and which reach the ground at later times. The intercept of a given ray cone with the ground is called an "isopemp." When computing sonic booms the ray perspective is appropriate, since one starts the analysis from the aircraft trajectory points and each isopemp is identified with flight conditions at a given time. As sketched in Figure 2, the isopemps are forward facing crescents.

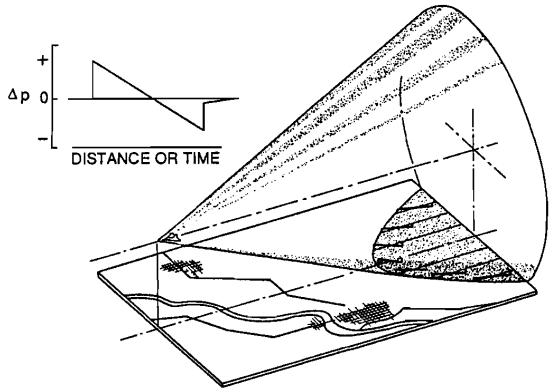

Figure 1. Sonic Boom Wave Field

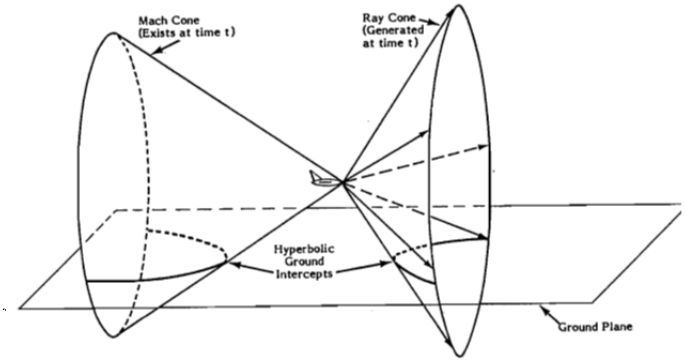

Figure 2. Wave versus Ray Viewpoints

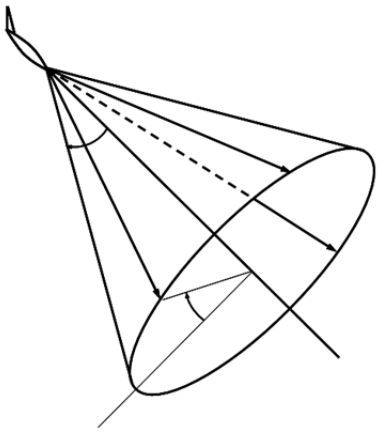

Figure 3. Ray Cone in Diving Flight

Figures 1 and 2 are drawn for steady level flight. If the aircraft climbs or dives, the ray cone tilts along with it. Figure 3 shows a ray cone in diving flight. At the angle in the figure the isopemp would still be a forward facing crescent, but would wrap around further than shown in Figure 2. In a steeper dive the isopemp could go full circle. If the vehicle is climbing at an angle steeper than the ray cone angle, there will be no boom at the ground. During very steep descent (near vertical) and at high Mach numbers the rays can be emitted at a shallow enough angle that they would refract upward and not reach the ground. For a descending vehicle that eventually decelerates to subsonic speed, some part of the trajectory will generate boom that reaches the ground.

Supersonic vehicles can turn and accelerate or decelerate. That affects the boom loudness, and under some conditions cause focused superbooms. Figure 4 is a sketch of rays from an accelerating aircraft. As the Mach number increases the ray angles steepen. The rays cross and overlap, with the focus along the "caustic" line indicated in the figure. The boom on a focusing ray is a normal N-wave before it gets close to the caustic, is amplified by a factor of two to five as it reaches the caustic, then is substantially attenuated as a "post-focus" boom after it passes the caustic.

Figure 5 shows the isopemps for this type of acceleration focus. The focal zone is the concentrated region at the left end of the footprint. The maximum focus area – where the boom is more than twice the unfocused normal boom – is very narrow, generally a hundred yards or less.

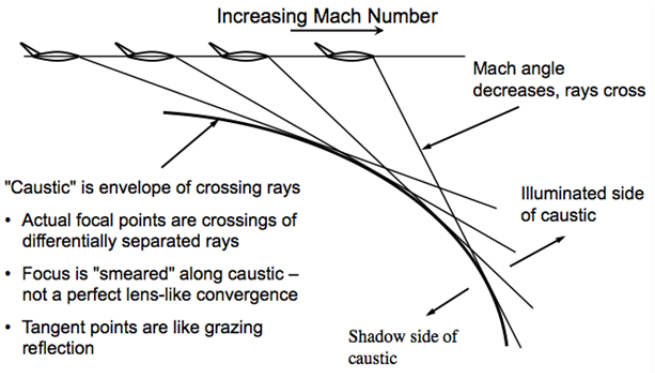

Figure 4. Ray Crossing and Overlap in an Acceleration Focus

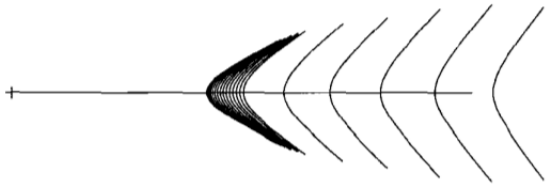

Figure 5. Isopemp Overlap in an Acceleration Focus

3.0 Falcon 9 Descent Sonic Boom

Data file "Orbcomm2_Nominal_Landing_r2007_80_12.ASC" containing the Stage 1 trajectory from separation through final descent was received from SpaceX on 1 June 2014. The descent portion is supersonic from shortly after the apogee until it passes through an altitude just below 30,000 feet. Most of the descent is unpowered. There is a retro entry burn that occurs from around 224,000 feet until around 143,000 feet.

The boom footprint was computed using PCBoom.[1,2] The vehicle is a cylinder generally aligned with the velocity vector, descending engines first. It was modeled via PCBoom's drag-dominated blunt body mode,[3] which has been validated for entry vehicles.[4] Drag is determined by vehicle weight and the kinematics of the trajectory. Kinematics include the effect of the retro burn. Figure

6 shows the sonic boom footprint, in the form of overpressure contours, pounds per square foot (psf). The ground track of the boom-producing part of the trajectory is shown in the figure. There is a broad forward-facing crescent region generated as the vehicle descends below 200,000 feet during the retro burn. After the burn finishes there is an oval boom footprint region that ends when speed becomes subsonic. There is a narrow focus line, seen as the 2 and 3 psf contours and the western edge of the crescent, generated as the vehicle accelerates at the end of the retro burn. At lower altitudes drag slows the descent, so boom following the focus is conventional carpet boom.

- The boom on the shoreline at just north of Cape Canaveral is just under 1.0 psf. To the west, boom amplitude falls to 0.2 psf at the edge of the footprint around Titusville.
- The highest boom levels off-shore are up to 3.5 psf in the narrow focus region just inside the forward facing crescent. This zone is narrow – about 100 yards wide. The location will vary with weather conditions, so it is very unlikely that any given location will experience the focus more than once over multiple events.
- The broad crescent includes land area around Daytona Beach. Boom in that area will generally be in the 0.2 to 0.3 psf range. It will exceed 0.5 psf along the focus line between Port Orange and Daytona Beach. There is a local higher focus region, up to about 1.4 psf, northwest of Deltona. Again, the location will vary from event to event, so it is unlikely any location would experience a focus multiple times.

Booms in the 0.2 to 0.3 psf range could be heard by someone who is expecting it and listening for it, but usually would not be noticed. Booms of 0.5 psf are more likely to be noticed, and booms of 1.0 psf are certain to be noticed. Some residents may be concerned about property damage. The most common sonic boom property damage is to fragile items like glass. The probability of a 1 psf boom breaking a typical residential window is somewhat less than one in a million.[5]

The primary effect of the boom in the on-shore communities would be people who hear it – especially in the narrow focal zone – wondering what it is. If the public is notified of this event and knows what to expect, adverse reaction can be minimized. Sonic booms from Space Shuttle landing, which were much larger than the expected boom from this vehicle, generated few complaints because the public was informed.

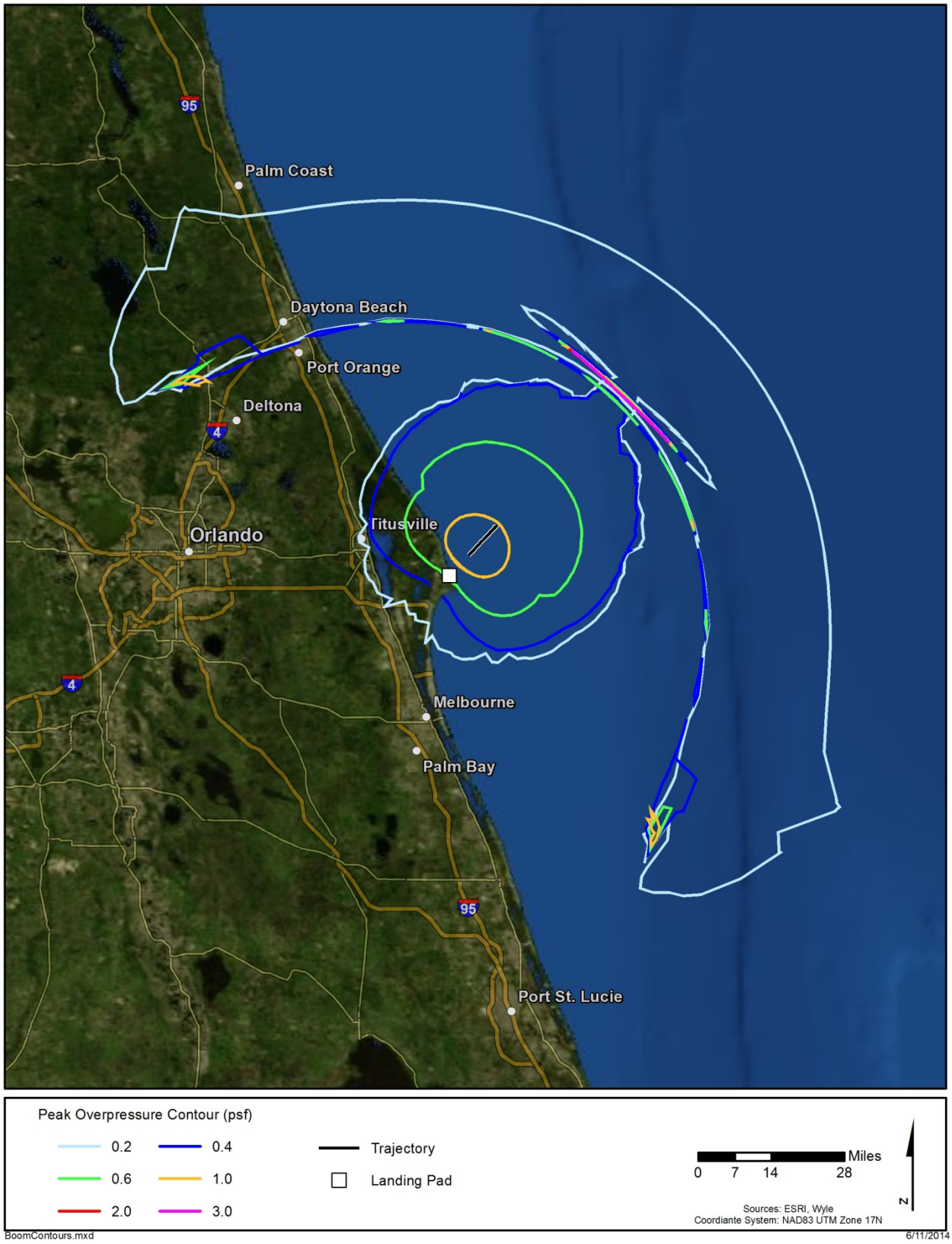

Figure 6. Sonic Boom Contours from Falcon 9 Descent

References

1. Plotkin, K.J., and Grandi, F., "Computer Models for Sonic Boom Analysis: PCBoom4, CABoom, BooMap, CORBoom," Wyle Research Report WR 02-11, June 2002.
2. Page, J.A., Plotkin, K.J., and Wilmer, C., "PCBoom Version 6.6 Technical Reference and User Manual," Wyle Report WR 10-10, December 2010.
3. Tiegerman, B., *Sonic Booms of Drag-Dominated Hypersonic Vehicles*, PhD Thesis, Cornell University, August 1975.
4. Plotkin, K.J., Franz, R.J., and Haering, E.A. Jr., "Prediction and measurement of a weak sonic boom from an entry vehicle," *J. Acoust. Soc., Am.*, Vol 120, p 3077, 2006.
5. Hershey, R.L., Higgins, T.H., and Magrab, E.B., "Application of the response probability density function technique to predicting the probability of sonic-boom glass breakage," *J. Acoust. Soc., Am.*, Vol 55, No 5, pp 1009-1017, May 1974.

Appendix F
USACE Wetland Determination Data Form

WETLAND DETERMINATION DATA FORM – Atlantic and Gulf Coastal Plain Region

Project/Site: Launch Complex 13 City/County: Brevard Sampling Date: 5/28/14

Applicant/Owner: Space X State: Florida Sampling Point: Wetland pt 186

Investigator(s): Mark Ausley Section, Township, Range: S 17/ T 23S/ R 38E

Landform (hillslope, terrace, etc.): coastal scrub Local relief (concave, convex, none): none Slope (%): 1

Subregion (LRR or MLRA): Lat: 28.29.02 Long: 80.32.33 Datum:

Soil Map Unit Name: Canaveral Complex, gently undulating NWI classification: palustrine emergent

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No (If no, explain in Remarks.)

Are Vegetation ____, Soil ____, or Hydrology ____ significantly disturbed? Are "Normal Circumstances" present? Yes XX No

Are Vegetation ____, Soil ____, or Hydrology ____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X No	**Is the Sampled Area within a Wetland?** Yes X No
Hydric Soil Present?	Yes X No	
Wetland Hydrology Present?	Yes X No	

Remarks:

The area has been recently cut in an effort to eradicate Brazilian pepper and other non-native and/or exotic vegetation. Vegetation returning is predominately wetland interspersed with facultative and opportunistic species.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ☐ Surface Water (A1)
- ☐ High Water Table (A2)
- ☐ Saturation (A3)
- ☐ Water Marks (B1)
- ☐ Sediment Deposits (B2)
- ☑ Drift Deposits (B3)
- ☐ Algal Mat or Crust (B4)
- ☐ Iron Deposits (B5)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☐ Water-Stained Leaves (B9)
- ☐ Aquatic Fauna (B13)
- ☐ Marl Deposits (B15) **(LRR U)**
- ☐ Hydrogen Sulfide Odor (C1)
- ☑ Oxidized Rhizospheres along Living Roots (C3)
- ☐ Presence of Reduced Iron (C4)
- ☐ Recent Iron Reduction in Tilled Soils (C6)
- ☑ Thin Muck Surface (C7)
- ☐ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ☐ Surface Soil Cracks (B6)
- ☑ Sparsely Vegetated Concave Surface (B8)
- ☐ Drainage Patterns (B10)
- ☐ Moss Trim Lines (B16)
- ☐ Dry-Season Water Table (C2)
- ☐ Crayfish Burrows (C8)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☐ Geomorphic Position (D2)
- ☐ Shallow Aquitard (D3)
- ☐ FAC-Neutral Test (D5)
- ☐ Sphagnum moss (D8) **(LRR T, U)**

Field Observations:

Surface Water Present?	Yes ____	No X	Depth (inches): ____
Water Table Present?	Yes ____	No X	Depth (inches): ____
Saturation Present? (includes capillary fringe)	Yes ____	No X	Depth (inches): ____

Wetland Hydrology Present? Yes X No

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Evidence of hydrology persists although at the time of sampling no surface water was observed. Additionally, a soil pit was dug and groundwater was not observed within the 12" pit.

VEGETATION (Four Strata) – Use scientific names of plants. Sampling Point: A

Tree Stratum (Plot size:)	Absolute % Cover	Dominant Species?	Indicator Status
1. none			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
	0 = Total Cover		
50% of total cover: no	20% of total cover: no		
Sapling/Shrub Stratum (Plot size: 3 meters)			
1. myrica cerifera	10	yes	FAC
2. schinus terebinthifolius	5	yes	FAC
3. baccharis halimifolia	10	yes	FAC
4.			
5.			
6.			
7.			
8.			
	25 = Total Cover		
50% of total cover: no	20% of total cover: yes		
Herb Stratum (Plot size: 1 meter)			
1. sonchus oleraceus	5	yes	FAC U
2. cladium jamaicense	15	yes	OBL
3. lipia nodiflora	5	yes	FAC
4. andropogon virginicus	10	yes	FAC
5. spartina bakerii	10	yes	FAC W
6.			
7.			
8.			
9.			
10.			
11.			
12.			
	45 = Total Cover		
50% of total cover: no	20% of total cover: yes		
Woody Vine Stratum (Plot size:)			
1. Mikania scandens	5	yes	FAC W
2.			
3.			
4.			
5.			
	5 = Total Cover		
50% of total cover: no	20% of total cover: no		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 7 (A)

Total Number of Dominant Species Across All Strata: 8 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 87.5% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species	15	x 1 =	15
FACW species	15	x 2 =	30
FAC species	40	x 3 =	120
FACU species	5	x 4 =	20
UPL species	0	x 5 =	0
Column Totals:	75 (A)		185 (B)

Prevalence Index = B/A = 2.47

Hydrophytic Vegetation Indicators:

- [x] 1 - Rapid Test for Hydrophytic Vegetation
- [x] 2 - Dominance Test is >50%
- [x] 3 - Prevalence Index is ≤3.0[1]
- [ ] Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Four Vegetation Strata:

Tree – Woody plants, excluding vines, 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/Shrub – Woody plants, excluding vines, less than 3 in. DBH and greater than 3.28 ft (1 m) tall.

Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

Woody vine – All woody vines greater than 3.28 ft in height.

Hydrophytic Vegetation Present? Yes x No

Remarks: (If observed, list morphological adaptations below).

SOIL

Sampling Point: A

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	%	Redox Features Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-1	Shell						Coarse	Top Layer composed of shell
1-6	Very Dark Grey	80					Fine Sand	organic bodies; dark sand
6-8	Dark Grey	20					Fine Sand	shell fragments; dark grey
8-12	Light Grey	100					Fine Sand	shell fragments; light grey

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains.

[2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Stratified Layers (A5)
- ☑ Organic Bodies (A6) **(LRR P, T, U)**
- ☐ 5 cm Mucky Mineral (A7) **(LRR P, T, U)**
- ☐ Muck Presence (A8) **(LRR U)**
- ☐ 1 cm Muck (A9) **(LRR P, T)**
- ☐ Depleted Below Dark Surface (A11)
- ☑ Thick Dark Surface (A12)
- ☐ Coast Prairie Redox (A16) **(MLRA 150A)**
- ☐ Sandy Mucky Mineral (S1) **(LRR O, S)**
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Dark Surface (S7) **(LRR P, S, T, U)**
- ☐ Polyvalue Below Surface (S8) **(LRR S, T, U)**
- ☐ Thin Dark Surface (S9) **(LRR S, T, U)**
- ☐ Loamy Mucky Mineral (F1) **(LRR O)**
- ☐ Loamy Gleyed Matrix (F2)
- ☐ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)
- ☐ Marl (F10) **(LRR U)**
- ☐ Depleted Ochric (F11) **(MLRA 151)**
- ☐ Iron-Manganese Masses (F12) **(LRR O, P, T)**
- ☐ Umbric Surface (F13) **(LRR P, T, U)**
- ☐ Delta Ochric (F17) **(MLRA 151)**
- ☐ Reduced Vertic (F18) **(MLRA 150A, 150B)**
- ☐ Piedmont Floodplain Soils (F19) **(MLRA 149A)**
- ☐ Anomalous Bright Loamy Soils (F20) **(MLRA 149A, 153C, 153D)**

Indicators for Problematic Hydric Soils[3]:

- ☐ 1 cm Muck (A9) **(LRR O)**
- ☐ 2 cm Muck (A10) **(LRR S)**
- ☐ Reduced Vertic (F18) **(outside MLRA 150A,B)**
- ☐ Piedmont Floodplain Soils (F19) **(LRR P, S, T)**
- ☐ Anomalous Bright Loamy Soils (F20) **(MLRA 153B)**
- ☐ Red Parent Material (TF2)
- ☐ Very Shallow Dark Surface (TF12)
- ☐ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: _____

Depth (inches): _____

Hydric Soil Present? **Yes** X **No** _____

Remarks:

sampling station is located within a wetland. Vegetation, hydrology, and soil characteristics are consistent with wetland communities located in this region (coastal Brevard).

Appendix G
Biological Opinion

United States Department of the Interior

U. S. FISH AND WILDLIFE SERVICE

7915 BAYMEADOWS WAY, SUITE 200
JACKSONVILLE, FLORIDA 32256-7517

IN REPLY REFER TO:
FWS Log No. 41910-2014-F-0259

September 17, 2014

Mr. Michael Blaylock, Chief, Environmental Conservation
Department of the Air Force, 45th Space Wing
45 CES/CEIS
1224 Jupiter Street
Patrick AFB, Florida 32925-3343
(Attn: Angie Chambers)

Dear Mr. Blaylock:

This document is the Fish and Wildlife Service's (Service) biological opinion based on our review of the Biological Assessment (BA) for the proposed SpaceX landing of the Falcon first stage at LC-13 on Cape Canaveral Air Force Station (CCAFS) in Brevard County, Florida, and its effects on the Florida scrub-jay *(Aphelocoma coerulescensy,* the southeastern beach mouse (*Peromyscus polionotus niveiventris)*, the eastern indigo snake (*Drymarchon corais couperi*), the loggerhead turtle (*Caretta caretta*), green turtle (*Chelonia mydas*), leatherback turtle (*Dermochelys coriacea*), hawksbill turtle (*Eretmochelys imbricata*), Kemp's ridleysea turtle (*Lepidochelys kempii*), American Alligator (*Alligator mississippiensis*), and the PipingPlover (*Charadrius melodus*) per section 7 of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 et seq.). Your request for formal consultation was received on July 11, 2014.

The 45th Space Wing (45 SW) has determined that the proposed project may affect, and is likely to adversely affect, the Florida scrub-jay, southeastern beach mouse, and the eastern indigo snake. The Service concurs with your determination. The 45 SW also determined that the proposed project may affect, but is not likely to adversely affect the loggerhead, green, leatherback, hawksbill, and Kemp's ridley sea turtles, the American Alligator, and the Piping Plover. Based on our discussions and review of the project plans, the Service concurs with this determination for these species. With respect to sea turtles and project-related lighting, and you will provide a Light Management Plan for the proposed LC-13 if actions that may impact sea turtles may occur during the proposed project. This plan will be reviewed and approved by the Service prior to the beginning of LC-13 operations.

This biological opinion is based on information provided in the final BA for the proposed LC-13 actions received on August 15, 2014, telephone conference call of May 29, 2014 with CCAFS and SpaceX and their consultant, and other sources of information. A complete administrative record is on file at the Ecological Service Office in Jacksonville, Florida

CONSULTATION HISTORY

On May 29, 2014, the Service participated in a conference call with representatives from CCAFS and SpaceX to discuss the Proposed Actions at LC-13. At that meeting, the Service discussed with representatives of the 45 SW the impacts of the proposed project on federally listed species.

On June 8-12, 2014, CCAFS staff conducted beach mouse surveys in southeastern beach mouse habitat along the primary Atlantic Ocean dune area east of LC-13 to determine potential effects of the proposed action. Southeastern beach mouse were captured in this area.

On June 21, 2014, the Service received an email from representative of the 45th Space Wing requesting information on the proposed project.

On July11, 2014, the Service received copies of the Biological Assessment and draft Environmental Assessment for the proposed project.

On August 8, 2014, the Service requested additional information to clarify the Biological Assessment.

On August 12, 2014, the Service had all the necessary information to complete a Biological Opinion.

BIOLOGICAL OPINION

DESCRIPTION OF THE PROPOSED ACTION

The proposed action area is LC-13 and the land east of LC-13 extending to the Atlantic Ocean beach dune. LC-13 is located in the east-central portion of CCAFS between LC-12 to the south and LC-14 to the north, all of which connect to ICBM road. The Proposed Action area is located in and around the existing LC-13 complex. The area located within the fence line has been loosely maintained, comprised of a few scattered trees and herbaceous groundcover. Beyond the fence line, within the limits of the Proposed Action, the site contains two (2) distinct habitat types. The majority of the area beyond the fence line is best described as coastal scrub. This habitat type is predominantly a forested area interspersed with dense patches of saw palmetto. The Proposed Action area also contains a ditch between the fence line and the beach, and extends from the northern end of the proposed action area to the south.

The area within the fence line of LC-13 contains remnants of the launch pad and ancillary support structures and represents approximately 8.16 acres. Species observed within this area include sand cordgrass (*Spartina bakerii*), crowfoot grass (*Dactyloctenium aegyptium*), prickly pear (*Opuntia humifusa*), saw palmetto (*Serenoa repens*), Brazilian pepper (*Schinus terebinthifolius*), sand live oak (*Quercus geminata*), cabbage palm (*Sabal palmetto*), beach sunflower (*Helianthus debilis*), dog fennel (*Eupatorium capillifolium*), ragweed (*Ambrosia* sp.), and pepper grass (*Lepidium virginicum*).

The coastal scrub community dominates the majority of the Proposed Action area representing 46.71 acres. This community type is comprised by a mix of coastal and oak scrub; scrub oaks are the dominant canopy species but the area is overgrown and contains stands of Brazilian pepper. This coastal scrub community does not appear to have undergone land management activities in recent years and contains a dense, mature canopy. Species observed within this community type include sand live oak, live oak (*Quercus virginiana*), myrtle oak (*Quercus myrtifolia*), Brazilian pepper, tough buckthorn (*Bumelia tenax*), cabbage palm, and Spanish bayonet (*Yucca aloifolia*). This habitat type has a closed canopy along with a dense understory comprised of saw palmetto, greenbrier (*Smilax* sp.), beauty berry (*Callicarpa americana*), wax myrtle (*Myrica cerifera*), rusty lyonia (*Lyonia ferrunginea*), partridge pea (*Galactia elliottii*), bracken fern (*Pteridium aquilinum*), and morning glory (*Ipomoea indica*).

The remaining habitat type within the Proposed Action area is a ditch. This man-made feature is a linear excavation approximately 0.85 acres extending from the north to the south within the Proposed Action area. The majority of the ditch has vertical side slopes and lacks any significant vegetative coverage. Species within the ditch are include cattail (Typha sp.), sawgrass (*Cladium jamaicense*), bulrush (*Scirpus* sp.), maidencane (*Panicum hemitomon*), and water pennywort (*Hydrocotyle umbellata*). Included within the ditch area is the narrow upland band containing spoil excavated from the ditch. This area is predominantly open but contains

species such as wax myrtle, prickly pear, sand cordgrass, Brazilian pepper, cabbage palm, saw palmetto, beauty berry, and grape vine

The Proposed Action area totals 55.72 acres comprised of a variety of construction levels. A portion of the action, 8.16 acres, is proposed within the fence line of the existing LC-13 complex. The remaining action will occur outside the fence line and result in impacts to natural undisturbed lands. The Proposed Action will result in the clearing of approximately 48.3 acres of vegetation as shown in the orange outline on Figure 5. The area proposed to be cleared extends from the east side of LC-13 to the western limits of the dune. Clearing using heavy machinery would not take place from the landward Toe of Slope (TOS) of the dune eastward (to the beach) or in areas that have been determined to be occupied by southeastern beach mice, approximately 5.4 acres. These areas which contain tall or "woody" plants such as sea grapes (*Coccoloba uvifera*) would be selectively hand-cut to prevent disturbance to beach mice burrows; beach mouse habitat would be marked with flagging. All other areas would be cleared using heavy machinery. Cleared material would be placed in wheeled dump trucks for removal from that area. Long-term maintenance along the eastern limits of the Proposed Action area near the primary dune would include selective cutting to maintain "woody" plants below three feet in height, and managed to minimize vegetation height, but would not be compacted or filled. The remaining land area east of the ditch would be managed initially to maintain all vegetation to less than three feet in height. Wheeled "roller/copper" machinery would be used on an annual basis to minimize vegetation grow-back height. Each annual maintenance visit would be preceded by a natural resource survey to determine presence/absence of listed wildlife species prior to any site activity (gopher tortoise, scrub-jay, etc.). Surveys will consist of pedestrian transects and reviews of available site specific databases (in particular as it relates to scrub- jays). As time progresses and expected landing vehicle radar technology improves, vegetation maintenance visits may not be required, and the area may be able to be returned to a natural state and managed as a scrub-jay habitat again.

Of the 48.3 acres requiring clearing, approximately 22.68 acres extends east of the fence line and to the western limits of the onsite ditch. Once vegetation is removed from this area using heavy machinery, much of it would be graded using large, heavy tracked bull dozers. Material would either be removed to a suitable off-site area, or burned on location in accordance with USAF regulations as schedule and burn conditions permit. The grading of this area would be required to support construction of the two eastern 150' diameter pads, roadways to those pads, and approximately one half of the 800 foot diameter area around the main landing pad. Construction of stormwater run-off systems (swales and retention ponds) would also occur in this area.

Each of the new road-ways would be constructed of compacted soil and appropriate pervious material to support a large tracked crane, and its load of a first stage Falcon vehicle. Each road would be approximately 40 feet wide and would include swales on either side of the roads. Construction of this road and associated swales/retention area is included in the estimated area of vegetation removal. Long-term maintenance for the area between LC-13 and the ditch is expected to be mowed grass. Standard large-scale grass mowing equipment would be used on a periodic basis to maintain vegetation to about three inches in height in this area. It is not expected that a natural resource survey would be required prior to mowing events. Should gopher tortoise burrows appear, the mowers would avoid these burrows. The 45th SW natural resource personnel would be notified if any burrows were found to encroach upon landing pads or roadways for removal. Tortoises would be excavated by Florida Fish and Wildlife Conservation Commission (FFWCC) authorized agents using a track hoe or via bucket trapping. Tortoises would be relocated onsite to an USAF approved recipient site. The USAF has not decided where specifically the tortoises would be relocated; however, proposed sites being considered are LMU 10, 110, 112, 114 and/or 119. All of these units have undergone restoration within the past two years and have suitable habitat available to support these tortoises. A survey would be done at the recipient site to ensure the unit is not already occupied and/or would not result in overpopulation with the additional tortoises.

The USAF is proposing to restore approximately 97 acres in Land Management Unit (LMU) 33 to compensate for impacts to scrub habitat. A combination of mechanical treatment and prescribed burning would be used to

restore habitat. Any vegetation encountered that is optimal height for scrub-jays will be avoided and left untreated. This LMU is located adjacent to occupied habitat and therefore will provide acreage for scrub-jays to expand. Additionally, the USAF has future plans to restore the remaining part of LMU 33 to assist land managers with the corridor connecting the core population of jays on CCAFS. Although the area in which the Proposed Action will occur is not currently occupied, to reduce the potential to impact nesting jays, a survey would be conducted prior to clearing to ensure no jays are nesting within 300' of clearing activities.

The restoration of LMU 33 is expected to start within three months of ground breaking at LC-13 and it is expected that all restoration would be completed within 12 months. Controlled burning of the unit, if required, would be conducted as soon as range scheduling allows. Due to the height of the vegetation in the unit, it is expected that much of the vegetative debris would be hauled off and/or disposed on-site using an air curtain incinerator. All other vegetation that is of suitable height would be left and burned as scheduling permits. Yearly maintenance would include monitoring and control of invasive species, as well as maintenance of any artificial openings created during restoration activities. LMU 33 would be placed on a 5-7 year burn rotation schedule and roller chopping would occur as the unit exceeds optimal scrub-jay height. Space X will provide funding for the restoration and maintenance of this site.
As a result of the Proposed Action, it is anticipated that a short-term moderate level of noise would be generated from clearing and construction activities within the action area. During landing operational periods, expected to be 12 times per year, the Falcon vehicle would produce engine noise and sonic boom noise. Engine noise generated as the vehicle descends from between 250 and 1000 meters above the landing pad would be the result of only one engine, rather than nine engines used to launch the vehicle. Therefore the noise level would be much less than typical noise produced from launch vehicles. Sonic boom noise produced would be less than 1 psf in the local CCAFS area (Wyle, 2014).

STATUS OF THE SPECIES/CRITICAL HABITAT

This section provides pertinent biological and ecological information for the Florida scrub-jay, southeastern beach mouse, and eastern indigo snake, as well as information about their status and trends throughout their entire range. We use this information to assess whether a federal action is likely to jeopardize the continued existence of the above-mentioned species. The "Environmental Baseline" section summarizes information on status and trends of the Florida scrub-jay, southeastern beach mouse, and eastern indigo snake specifically within the action area. These summaries provide the foundation for our assessment of the effects of the proposed action, as presented in the "Effects of the Action" section.

FLORIDA SCRUB-JAY

Species/Critical Habitat Description

Florida scrub-jays are about 10 to 12 inches long and weigh about 3 ounces. They are similar in size and shape to the blue jay *(Cyanocitta cristata),* but differ significantly in coloration (Woolfenden and Fitzpatricl 1996a). Unlike the blue jay, the scrub-jay lacks a crest. It also lacks the conspicuous white-tipped wing and tail feathers, black barring, and bridle of the blue jay. The Florida scrub-jay's head, nape, wings, and tail are pale blue, and its body is pale grey on its back and belly. Its throat and upper breast are lightly striped and bordered by a pale blue• grey "bib." Scrub-jay sexes are not distinguishable by plumage, and males, on the average, are only slightly larger than females (Woolfenden 1978). The sexes may be differentiated by a distinct "hiccup" call vocalized only by females (Woolfenden and Fitzpatrick 1986). Scrub-jays that are less than about five months of age are easily distinguishable from adults; their plumage

is smokey grey on the head and back, and they lack the blue crown and nape of adults. Molting occurs between early June and late November and peaks between mid-July and late September (Bancroft and Woolfenden 1982). During late summer and early fall, when the first basic molt is nearly done, fledgling

scrub-jays may be indistinguishable from adults in the field (Woolfenden and Fitzpatrick 1984). The wide variety of vocalizations of the scrub-jay is described in detail in Woolfenden and Fitzpatrick (I 996b).

No critical habitat has been designated for this species; therefore none will be affected by the proposed project.

Life History/Population Dynamics

Scrub-jays are non-migratory, extremely sedentary, and have very specific habitat requirements (Woolfenden 1978). They usually reside in oak scrub vegetated with sand oak, myrtle oak, inopine oak, and Chapman oak, along with saw palmetto, scrub palmetto, scattered sand pipe, and rosemary. Such habitat occurs only on fine, white, drained sand, along, along the coastlines in Florida, and in dunes deposited during the Pleistocene, when sea levels were much higher than at present (Laessle 1958, 1968). Scrub-jays are rarely found in habitats with more than 50 percent canopy cover over three meters in height (U.S. Fish and Wildlife Service 1990). The habitat required for the scrub-jay greatly restricts the bird's distribution. Active management either through burning or mechanical clearing is necessary to maintain optimum conditions. In general, scrub-jay habitat consists of dense thickets of scrub oaks less than nine feet tall, interspersed with bare sand used for foraging and storing of acorns (U.S. Fish and Wildlife Service 1990).

Florida scrub-jays are monogamous and remain mated throughout the year (Sprunt 1946; Woolfenden 1978). Scrub-jays have a social structure that involves cooperative breeding, a trait that the other North American species of scrub-jays do not show (Woolfenden and Fitzpatrick 1984). Scrub-jays live in families ranging from two birds (a single mated pair) to extended families of eight adults and one to four juveniles. Fledgling scrub-jays stay with the breeding pair in their natal territory as "helpers, forming a closely-knit cooperative family group. Pre- breeding numbers are generally reduced to either a pair with no helpers or families of three to four individuals (a pair plus one or two helpers). The presence of helpers generally increases reproductive success and survival within the group, which naturally causes family size to increase (Woolfenden and Fitzpatrick 1978).

Scrub-jays. have a well-developed intrafamilial dominance hierarchy with breeder males most dominant, followed by helper males, Breeder females, and finally, female helpers (Woolfenden and Fitzpatrick 1977). Helpers take part in sentinel duties (McGowan and Wool fenden 1989), territorial defense, predator-mobbing, and the feeding of both nestlings (Stallcup and Woolfenden 1978) and fledglings (McGowan and Woolfenden 1990). The well-developed sentinel system involves having one individual occupying an exposed perch watching for predators or territory intruders. When a predator is seen, the sentinel scrub-jay gives a distinctive warning call, and all family members seek cover in dense shrub vegetation (Fitzpatrick *et al.* 1991).

Florida scrub-jay pairs occupy year-round, multi-purpose territories (Woolfenden and Fitzpatrick 1984; Fitzpatrick *et al.* 1991). Territory size averages 22 to 25 acres, with a minimum size of about 12 acres. The availability of territories is a limiting factor for scrub-jay populations. Because of this limitation, non-breeding adult males may stay at the natal territory as helpers for up to five years, waiting for either a mate or territory to become available (Fitzpatrick *et al.* 1991). Birds may become breeders in several ways: (1) by replacing a lost breeder on a non-• natal territory (Woolfenden and Fitzpatrick 1984); (2) through "territorial budding," where a helper male becomes a breeder in a segment of its natal territory (Woolfenden and Fitzpatrick 1978); (3) by inheriting a natal territory following the death of a breeder; (4) by establishing a new territory between existing territories (Woolfenden and Fitzpatrick 1984); or (5) through "adoption" of an unrelated helper by a neighboring family followed by resident mate replacement (B. Toland, USFWS, pers. comm. 1996). Territories can also be created by restoring habitat through effective habitat management efforts in areas that are overgrown (Thaxton and Hingtgen 1994).

To become a breeder, a scrub-jay must find a territory and a mate. Evidence presented by Woolfenden and Fitzpatrick (1984) suggests that scrub-jays are monogamous. The pair retains ownership and sole breeding privileges in its particular territory year after year. Courtship to form the pair is lengthy and ritualized, and involves posturing and vocalizations made by the male to the female (Woolfonden and Fitzpatrick 1996b). Copulation between the pair is generally out of sight of other scrub-jays (Woolfenden and Fitzpatrick 1984). These authors also reported never observing copulation between unpaired scrub-jays or courtship behavior between a female and a scrub-jay other than her mate. Age at first breeding in the scrub-jay varies from one to seven years, although most individuals become breeders between two and four years of age (Fitzpatrick and Woolfenden 1988). Persistent breeding populations of scrub-jays exist only where there are scrub oaks in sufficient quantities to provide an ample winter acorn supply, cover from predators, and nest sites during spring (Woolfenden and Fitzpatrick 1996a).

Nesting is synchronous, normally occurring from 1 March through 30 June (Woolfenden and Fitzpatrick 1990; Fitzpatrick *et al.* 1991). On the Atlantic Coastal Ridge and southern Gulf coast, nesting may be protracted through the end of July (B. Toland, USFWS, pers. comm. 1996; J. Thaxton, Uplands, Inc., pers.comm. 1998). In suburban habitats, nesting is consistently initiated earlier (March) than in natural scrub habitat (Fleischer 1996), although the reason for this difference is unknown.

Clutch size ranges from 1 to 5 eggs, but is typically 3 or 4 eggs. Clutch size is generally larger (up to 6 eggs) in suburban habitats, and the birds try to rear more broods per year (Fleischer 1996). Eggs are incubated for 17 to 18 days, and fledging occurs 16 to 21days after hatching (Woolfenden 1974, 1978; Fitzpatrick *et al.* 1991). Only the breeding female incubates and broods eggs and nestlings (Woolfenden and Fitzpatrick 1984). Annual productivity must average at least two fledged per pair for a population of scrub-jays to support long-term stability (Woolfenden and Fitzpatrick 1990; Fitzpatrick *et al.* 1991).

Fledglings depend upon adults for food for about 10 weeks, during, which time they are fed by both breeders and helpers (Woolfenden 1975; McGowan and Woolfenden 1990). Survival of scrub-jay fledglings to yearling age class averages about 35 percent in optimal scrub, while annual survival of both adult males and females averages about 80 percent (Fitzpatrick *et al.* unpubl. data). Data from Archbold Biological Station, however, suggest that survival and reproductive success of scrub-jays in sub-optimal habitat is substantially lower (Woolfenden and Fitzpatrick 1991). These data help explain why local populations inhabiting unburned, late successional habitats become extirpated. The longest observed lifespan of a Florida scrub-jay is 15.5 years at Archbold Biological Station in Highlands County (Woolfenden and Fitzpatrick 1996b).

Scrub-jays are nonmigratory and permanently territorial. Juveniles stay in their natal (Woolfenden and Fitzpatrick 1984). Once scrub-jays pair and become breeders, they stay on their breeding territory until death. In suitable habitat, fewer than five percent of scrub-jays disperse more than five miles (Fitzpatrick *et al.* 1991). All documented long distance dispersals have been in unsuitable habitat such as woodland, pasture, or suburban plantations. Scrub-jay dispersal behavior is affected by intervening land uses. Protected scrub habitats will most effectively sustain scrub-jay populations if they are located within surrounding habitat types that can be used and traversed by scrub-jays.

Brushy pastures, scrubby corridors along railways and road rights-of-way, and open burned flatwoods offer links for colonization among scrub-jay subpopulations. Stith *et al.* (1996) believed that a dispersal distance of five miles is close to the biological maximum for scrub-jays.

Scrub-jays forage mostly on or near the ground, often along the edge of natural or man-made openings. They visually search for food by hopping or running along the ground beneath the scrub or by jumping from shrub to shrub. Insects, particularly orthopterans (e.g., locusts, crickets, grasshoppers, beetles) and lepidopterau (e.g., butterfly and moth) larvae, form most of the animal diet throughout most of the year (Woolfenden and Fitzpatrick 1984). Acorns are the most important plant food (Fitzpatrick *et al.* 1991). From August to November each year, scrub-jays may harvest and cache 6,000 to 8,000 oak acorns throughout their territory.

It is estimated that 1/3 of these acorns are later recovered and eaten. Caching allows scrub-jays to eat acorns every month of the year. This reliance on acorns and caching may constitute a major reason for the scrub-jay's restriction to the oak scrub and sandy ridges within Florida (Fitzpatrick *et al.* 1991).

Status and Distribution

The Florida scrub-jay is found exclusively in peninsular Florida, and is restricted to scrub habitat (U.S. Fish and Wildlife Service 1990). The Florida scrub-jay was listed as a threatened species on June 3, 1987 (52 FR 2d115-20719). The main causes responsible for the decline were as follows:

The Present or Threatened Destruction, Modification, or Curtailment of its Habitat or Range:
The existence of scrub-jays throughout their range depends on the existence of a particular serial stage of oak scrub habitat with unvegetated openings in sandy soils. This habitat occurs naturally only in localized patches associated with recent or ancient shoreline deposits. By the time of listing, large proportions of these habitat patches had been converted for human use, or were slated for imminent conversion. Most of the coastal scrub habitat had already been cleared for beachfront hotels, houses, and condominiums, and much of the central Florida scrub had been converted to citrus groves, housing developments, and commercial real estate. It was estimated that 40 percent of occupied scrub habitat had already been converted to other uses, and total population of the species had declined by at least halt: As a result of rapid increase in human population numbers throughout central Florida, the pace of housing and agricultural development had accelerated since the 1960s, and it showed no signs of slowing.

Overutilization for Commercial, Recreational, Scientific, or Educational Purposes
Reported shooting of scrub-jays and collection of the species as pets were considered threats.

Disease or Predation:
Disease and predation were not believed to be major threats at the time of listing.

The Inadequacy of Existing Regulatory Mechanisms:
The only laws protecting the Florida scrub-jay prior to the time of listing were the Migratory Bird Treaty Act of 1918 (MBTA) (16 U.S.C. 703 *et seq.)* and Florida State Law (Chapter 68A-27.004, Florida Administrative Code). Neither of these laws protected the birds from habitat destruction, which constituted the major threat to the species.

Other Natural or Manmade Factors Affecting its Continued Existence:
Suppression of fire by humans was identified as a factor in species' decline at the time of the listing. Historically, lightning strikes started fires, which maintained the sparse low scrub habitat needed by Florida scrub-jays. Human efforts to suppress these fires to protect human interests allowed the scrub to become too dense and tall to support populations of scrub-jays. Vehicular mortality of scrub jays due to accidental collisions along roadsides was recognized as a cause of the decline in some parts of the species' range.

Continued and current threats to the species include:

The Present or Threatened Destruction, Modification, or Curtailment of its Habitat or Range:
Scrub habitats continued to decline throughout peninsular Florida since listing occurred, and habitat destruction continues to be one of the main threats to the Florida scrub-jay. Cox (I 987) noted local extirpations and major decreases in numbers of scrub-jays and attributed them to the clearing of scrub for housing and citrus groves. Eighty percent or more of the scrub habitats have been destroyed along the Lake Wales Ridge since pre-human settlement (Fitzpatrick *et al* 1991). Fernald (1989), Fitzpatrick *et al.* (1991, 1994), and Woolfenden and Fitzpatrick (1996a) noted that habitat losses due to agriculture, silviculture, and commercial] and residential develop merit have continued to play arole In the decline in numbers of scrub-jays

throughout the state. State-wide, estimates of scrub habitat loss range from 70 to 90 percent (Bergen 1994; Woolfenden and Fitzpatrick 1 996a; Fitzpatrick *et al.* unpubl. data).

Toland (1999) estimated that about 85 percent of pre-European settlement scrub habitats had been converted to other uses in Brevard County. This is due mainly to development activity and citrus conversion, which were the most important factors that contributed to the scrub-jay decline between 1940 and 1990. A total of only 10,656 acres of scrub and scrubby flatwoods remain in Brevard County (excluding federal ownership), of which only 1,600 acres (15 percent) is in public ownership for the purposes of conservation. Less than 1,977 acres of an estimated pre• settlement of 14,826 acres of scrubby flatwoods habitat remain in Sarasota County, mostly occurring in patches averaging less than 2.5 acres in size (Thaxton and Hingtgen 1996). Only 10,673 acres of viable coastal scrubby flatwoods remained in the Treasure Coast region of Florida (Indian River, Saint Lucie, Martin, and Palm Beach Counties) according to Fernald (1989). He estimated that *95* percent of scrub had already been destroyed for development purposes in Palm Beach County. Habitat destruction not only reduces the amount of area scrub-jays can occupy, but also increases fragmentation of habitat. As more scrub habitat is altered, the habitat is cut into smaller and smaller pieces, separated from other patches by larger distances; such fragmentation increases the probability of genetic isolation, which is likely to increase extinction probability (Fitzpatrick *et al.* 1991; Woolfenden and Fitzpatrick 1991; Snodgrass *et al.* 1993; Stith *et al.* 1996; Thaxton and Hingtgen 1996). Dispersal distances of scrub-jays in fragmented habitat are further than in optimal unfragmented habitats, and demographic success is poor (Thaxton and Hingtgen 1996; Breininger 1999).

Overutilization for Commercial, Recreational, Scientific. or Educational Purposes: The Service knows of only a few cases where scrub-jays have been shot. One was in Volusia County which was investigated and prosecuted under the MBTA (J. Oliveros, USFWS, pers. comm.). The Florida Fish and Wildlife Conservation Commission (FWC) investigated a case in which three scrub-jays were shot in Highlands County (N. Douglass, FWC, pers. comm.). It does not seem that the small number and infrequent occurrence of scrub-jays taken in this manner has had an impact on the species.

Disease or Predation: Most Florida scrub-jays mortality probably is from predation (Woolfenden and Fitzpatrick 1996b). The second most frequent cause may be disease, or predation on disease-weakened jays (Woolfenden and Fitzpatrick 1996b). Known predators of Florida scrub-jays are listed by Woolfenden and Fitzpatrick (1990), Fitzpatrick *et al.* (1991), Breininger (1999), and K. Miller (FWC, in litt. 2004); the list includes eastern coachwhip (*Masticophis flagellum,* known to eat adults, nestlings, and fledglings), eastern indigo snake *(Drymarchon corais couperi,* known to eat adults and fledglings), rat snake (*Elaphe obsolete),* and corn snake *(E. guttata).* Mammalian predators include bobcats *(Lynx rufus),* raccoons *(Procyon lotor),* cotton rats *(Sigmodon hispidus,* known to eat eggs), and domestic cats *(Fe/is cattus,* known to eat adults). Franzreb and Puschock (2004) also have documented spotted skunks *(Spilogale putorius)* and grey fox (*Urocyon cinereoargenteusi* as mammalian predators of scrub jay nests. Fitzpatrick *et al. (1991)* suspected that populations of domestic cats are able to eliminate small populations of scrub-jays. Avian nest predators include great horned owls *(Bubo virginianus),* eastern screech-owl (*Otus asio),* red-tailed hawk (*Buteo jamaicensis),* northern harrier *(Circus cyaneus),* fish crow *(Corvus ossifragus),* boat-tailed grackle *(Quiscalus major),* common grackle (Q. *quiscula),* American crow (C. *brachyrhynchos),* blue jay *(Cyanocitta cristata),* and swallow-tailed kites *(Elanoides forficatusi.* Fitzpatrick *et al.* (1991) reported that overgrown scrub habitats are often occupied by the blue jay, which may be one factor limiting scrub-jay populations in such areas. Raptors which seem to be important predators of adult scrub-jays are merlin *(Falco columbariusi,* sharp-shinned hawk *(Accipiter striatusi),* and Cooper's hawk *(A. cooperii),* and northern harrier. During migration and winter, these four raptor species are present in areas which contain scrub habitat, and scrub-jays may experience frequent confrontations (as many as one pursuit a day) with them (Woolfenden and Fitzpatrick 1990). In coastal scrub, Woolfenden and Fitzpatrick (1996b) report that scrub-jays are vulnerable to predation by raptors in October, March, and April, when high densities of migrating accipiters and falcons are present. Woolfenden and Fitzpatrick (1996b) and Toland (1999) suggest that in overgrown scrub habitats, hunting efficiency for scrub-jay predators is increased. Bowman and Averill (1993) noted that scrub-jays

occupying fragments of scrub found in or near housing developments were more prone to predation by house cats and competition from blue jays and mockingbirds. Woolfenden and Fitzpatrick (1996a, 1996b) stated that proximity to housing developments (and increased exposure to domestic cats) needs to be taken into consideration when designing scrub preserves. Young scrub-jays are especially vulnerable to ground predators (e.g., snakes and mammals) before they are fully capable of sustained flight.

The Florida scrub-jay hosts 2 protozoan blood parasites *(Plasmodium cathemerium* and *Haemoproteus danilewskyi),* but incidence is low (M. Garvin pers. comm., cited in Woolfenden and Fitzpatrick 1996b). Several scrub-jays sick from these two agents in March 1992 survived to become breeders. The Florida scrub-jay carries at least 3 types of mosquito-borne encephalitis (St. Louis, eastern equine, and "Highlands jay"; M. Garvin and J. Day pers. comm., cited in Woolfenden and Fitzpatrick 1996b). Of particular concern is the arrival of West Nile virus (the agent of another type of encephalitis) in Florida during 2001; since corvids have been particularly susceptible to the disease in states north of Florida, it is expected that scrub-jays will be affected.

Woolfenden and Fitzpatrick (1996b) noted 3 episodes of elevated mortality (especially among juveniles) in 26 years at Archbold Biological Station. Each of these incidents occurred in conjunction with elevated water levels following unusually heavy rains in the fall, although high mortality does not occur in all such years. During the most severe of these presumed epidemics (August 1979 through March 1980), all but one of the juvenile cohort and almost half of the breeding adults died (Woolfenden and Fitzpatrick 1984; Woolfenden and Fitzpatrick 1990). The 1979-1980 incidents coincided with a known outbreak of eastern equine encephalitis among domestic birds in central Florida (J. Day pers. comm., cited in Woolfenden and Fitzpatrick 1996b). From the fall of 1997 through the spring of 1998, the continuing population decline of Florida scrub-jays along the Atlantic coast and in central Florida may have been augmented by an epidemic of unknown origin (Breininger 1999).

At CCAFS, Stevens and Hardesty (1999) noted a decline in juvenile survival from 60 to 70 percent in the preceding years to only 16 percent in 1997-98. It stayed low (only 25 percent) in 1998-99 before again climbing into the mid-60 percent range. Also, adult survival dropped from 70 to 80 percent in the preceding years to 50 to 60 percent in 1997-98. Overall, their annual surveys documented the largest one-year drop (pairs decreased by 17 percent and birds by 20 percent) in this population at the same time as the presumed state-wide epidemic. In winter-summer of 1973, 15 species of helminth fauna (including 8 nematodes, 5 trematodes, 1 cestode, and 1 acanthocephalan) were found in 45 Florida scrub-jays collected in south-central Florida; the parasite load was attributed to a varied arthropod diet (Kinsella 1974). These naturally-occurring parasites are not believed to have a negative impact on scrub-jay population levels.

Larvae of a fly, *Philornis* (= *Neomusca) porteri,* occur irregularly on scrub-jay nestlings. The species pupates in the base of the nest; larvae locate in nares, mouth flanges, bases of remiges, and toes; apparently no serious effect on the scrub-jay host occurs (Woolfenden and Fitpatrick 1996b). Additionally, one indescribable chewing louse *(Myrsidea* sp., R. Price pers, comm., cited in Woolfenden and Fitzpatrick 1996b), one wing-feather mite *(Pterodectes* sp.), two chiggers *(Eutrombicula lipovskyana),* and a flea *(Echidnophaga gallinacea;* J. Kinsella pers. comm., cited in Woolfenden and Fitzpatrick 1996b) occur on some individuals, usually at low densities. Nymphs and larvae of four ticks (*Amblyomma americanum, A. tuberculatum, Haemaphysalis leporispalustris,* and *Jxodes scapularis)* are known to occur on scrub-jays, as well as the larvae of the tick *Amblyomma maculatum* (L. Durden and J. Keirans pers. comm., cited in Woolfenden and Fitzpatrick 1996b). These naturally occurring parasites are not believed to have a negative impact on scrub-jay population levels.

The Inadequacy of Existing Regulatory Mechanisms: Woolfenden and Fitzpatrick (1996a) state the importance of enforcing existing federal laws regarding the management of federal lands as natural ecosystems for the long-term survival of the Florida scrub-jay. The Service consults regularly on activities on federal lands which may affect scrub-jays and also works with private landowners through section 10 (a)

(1) (B) incidental take permitting process of the Act when take is likely to occur and no federal nexus is present. Florida's State Comprehensive Plan and Growth Management Act of 1985 is administered mostly by regional and local governments. Regional Planning Councils administer the law through Development of Regional Impact Reviews; at the local level, although comprehensive plans contain policy statements and natural resource protection objectives, they are only effective if counties enact and enforce ordinances. As a general rule, counties have not enacted and/or enforced ordinances that are effective in protecting scrub-jays (Fernald 1989).

The Wildlife Code of the state of Florida (Chapter 68A, Florida Administrative Code) prohibits taking of individuals of threatened species, or parts thereof, or their nests or eggs, except as authorized. The statute does not prohibit clearing of habitat occupied by protected species, which limits the ability of the FWC to protect the Florida scrub-jay and its habitat.

Other Natural or Manmade Factors Affecting its Continued Existence: Human interference with natural fire regimes has continued to play a major part in the decline of the scrub-jay and today may exceed habitat loss as the single most important factor (Woolfenden and Fitzpatrick 1991, 1996a; Fitzpatrick *etal.* 1994). Lightning strikes cause virtually all naturally-occurring fires in south Florida scrub habitat (Abrahamson 1984; Hofstetter 1984). Fire has been noted to be important in maintenance of scrub habitat for decades (Nash 1895; Harper 1927; Webber 1935; Davis 1943; Laessle 1968; Abrahamson *et al.* 1984). Human efforts to prevent and/or control natural fires have allowed the scrub to become too dense and tall to support populations of scrub• jays, resulting in the decline of local populations of scrub-jays throughout the state (Fernald 1989; Fitzpatrick *et al.* 1994; Percival *et al.* 1995; Stith *et al.* 1996; Thaxton and Hingtgen 1996; Woolfenden and Fitzpatrick 1990, 1996a; Toland 1999). Woolfenden and Fitzpatrick 1990, 1996a; Toland 1999). Woolfenden and Fitzpatrick (1996a) cautioned, however, that fire applied too often to scrub habitat also can result in local extirpations. Experimental data at Archbold Biological Station (Fitzpatrick and Woolfenden, unpubl. data) show that fire-return intervals varying between 5 and 15 years are optimal for long• term maintenance of productive Florida scrub-jay populations in central Florida. These intervals also correspond with those yielding healthy populations of listed scrub plants (Menges and Kohfeldt 1995; Menges and Hawkes 1998). Optimal fire-return intervals may, however, be shorter in coastal habitats (Breininger and Schmalzer 1990; Scluna1zer and Hinkle 1992a, b; Breininger *et al.* 1995, 1998).

Stith *et al.* (1996) estimated that at least 2,100 breeding pairs were living in overgrown habitat. Toland (1999) reported that most of Brevard County's remaining scrub (estimated to be only 15 percent of the original acreage) is extremely overgrown due to fire suppression. He further suggests that the overgrowth of scrub habitats reduces the number and size of sand openings which are crucial to not only scrub-jays, but also many other scrub plants and animals.

Reduction in the number of potential scrub-jay nesting sites, acorn cache sites, and foraging sites presents a problem for scrub-jays. Fernald (1989) reported that overgrowth of scrub results not only in the decline of species diversity and abundance but also a reduction in the percentage of open sandy patches (Fernald 1989; Woolfenden and Fitzpatrick 1996b). Fitzpatrick *et al.* (1994) believed that fire suppression was just as responsible as habitat loss in the decline of the scrub• jay, especially in the northern third of its range. Likewise, the continued population decline of scrub-jays within Brevard County between 1991 and 1999 has been attributed mainly to the overgrowth of remaining habitat patches (Breininger *et al.* 2001). Breininger *et al.* (1999a) concluded that optimal habitat management is essential in fragmented ecosystems maintained by periodic fire, especially to lessen risks of decline and extinction resulting from epidemics and hurricanes.

Fitzpatrick *et al.* (1991, 1994) and Woolfenden and Fitzpatrick (1996a) expressed concern for the management practices taking place on federal lands at Ocala National Forest, MINWR/KSC, and CCAFS, all supporting large contiguous populations of Florida scrub-jays. They predicted that fire suppression and/or too frequent fires (on the latter two) and silvicultural activities involving the cultivation of sand pine on Ocala National Forest would be responsible for continuing decline of scrub-jays in these large contiguous areas of

scrub. These areas should be those where populations are most secure because of federal agencies' responsibilities under section 7(a) (I) of the Act. Monitoring of scrub-jay populations, demography, and nesting success is ongoing on all of these properties to assess the effectiveness of management practices in meeting scrub-jay recovery objectives.

Housing and commercial developments within scrub habitats are accompanied by the development of roads. Since scrub-jays often forage along roadsides and other openings in the scrub, they are often killed by passing cars. Research by Mumme *et al.* (2000) along a two-lane paved road indicated that clusters of Florida scrub-jay territories found next to the roadside represented population sinks (breeder mortality exceeds production of breeding-aged recruits), which could be supported only by immigration. Since this species may be attracted to roadsides because of the open habitat characteristics, road mortality presents a significant and growing management problem throughout the remaining range of the Florida scrub-jay (Dreschel *et al.*1990; Mumme *et al.* 2000), and proximity to high-speed paved roads needs to be considered when designing scrub preserves (Woolfenden and Fitzpatrick 1996a).

Another potential problem in suburban areas supporting Florida scrub-jays is supplemental feeding by humans (Bowman and Averill 1993; R. Bowman unpubl. data, cited in Woolfenden and Fitzpatrick 1996a; Bowman 1998). The presence of additional food may allow scrub-jays to persist in fragmented habitats, but recruitment in these populations is lower than in native habitats. However, even though human-feeding may postpone local extirpations, long-term survival cannot be ensured in the absence of protecting native oak scrub habitat, necessary for nesting.

Scrub-jays in suburban settings often nest high in tall shrubbery. During March winds, these nests tend to be susceptible to destruction (R. Bowman and G.E. Woolfenden unpubl data, cited in Woolfenden and Fitzpatrick 1996b; Bowman 1998).

Hurricanes pose a potential risk for Florida scrub-jays, although the exact impact of such catastrophic events remains unknown. Breininger *et al.* (1999b) modeled the effects of epidemics and hurricanes on scrub-jay populations in varying levels of habitat quality. Small populations of scrub-jays are more vulnerable to extirpation where epidemics and hurricanes are common. Storm surge from a category 3 to 5 hurricane could inundate entire small populations of scrub-jays, and existing habitat fragmentation could prevent repopulation of affected areas. However, this model also predicted that long-term habitat degradation had greater influence on extinction risk than hurricanes or epidemics.

Fernald (1989) reported that many of the relatively few remaining patches of scrub within the Treasure Coast region of Florida had been degraded by trails created by off-road vehicles, illegal dumping of construction debris, abandoned cars and appliances, or household waste. The invasion of these areas by exotic species, including Brazilian pepper *iSchinus terebinthifoliusi,* cypress pine *(Callttris* sp.), and Australian pine *iCasuarina equisetifoliai* also was a problem. Other human-induced impacts identified by Fernald include the introduction of domestic dogs *(Canisfamiliarisv* and cats, black rats *(Rattus rauusi)* greenhouse frogs *(Eleutherodactylus planlrostrisi)* giant toads *(Bz~fo marinusi)* Cuban tree frogs *tOsteopilus septentrionaiisi),* brown anoles *(Anolis sagrei),* and other exotic animal species. These exotic species may compete with scrub-jays for both space and food, although scrub-jays sometimes feed on them.

A statewide scrub-jay census was last conducted in 1992-1993, at which time there were an estimated 4,000 pairs of scrub-jays left in the Florida (Fitzpatrick *et al.* 1994). The scrub-jay was considered extirpated in 10 counties (Alachua, Broward, Clay, Dade, Duval, Gilchrist, Hernando, Hendry, Pinellas, and St. Johns), and were considered functionally extinct in an additional 5 counties (Flagler, Hardee, Levy, Orange, and Putnam), where ten or fewer pairs remained. Recent information indicates that there are at least 12 to 14 breeding pairs of scrubjays located within Levy County, higher than previously though (K. Miller, FWC, pers. comm.2004), and there is at least one breeding pair of scrub-jays remaining in Clay County (K. Miller, FWC, pers. comm.. 2004). A scrub-jay has been documented in St. Johns County as recently as2003 (J.B.

Miller, FDEP, in litt. 5/13/03). Populations are close to becoming extirpated in Gulf coast counties (from Levy south to Collier) (Fitzpatrick *et al.* 1994; Woolfenden and Fitzpatrick 1996a). In 1992-1993, population numbers in 19 of the counties were below 30 or fewer breeding pairs. In the past, most of these counties would have contained hundreds or even thousands of groups (Fitzpatrick *et al.* 1994). Based on the amount of destroyed scrub habitat, scrub-jay population loss along the Lake Wales Ridge is 80 percent or more since pre-European settlement (Fitzpatrick *et al.* 1991). Since the early 1980s, Fitzpatrick *et al.* (1994) estimated that in the northern third of the species' range, the Florida scrub-jay has declined between 25 and 50 percent. The species may have declined by as much as 25 to 50 percent in the last decade alone (Stith *et al.* 1996).

On protected lands, scrub-jays have continued to decline due to inadequate habitat management (Stith 1999). However, over the last several years, steps to reverse this decline have occurred, and management of scrub habitat is continuing in many areas of Florida (Hastie and Eckl 1999; Stith 1999; TNC 2001; A. Birch, Brevard County Environmentally Endangered Lands (EEL), pers. comm.; M. Camardese, CCAFS, pers.comm.).

Analysis of Brevard County historic aerial photography and soil maps suggest that pre-European settlement oak scrub, scrubby pine flatwoods, and coastal scrub/strand covered at least 53,000 acres outside of federal lands (Toland 1999). Assuming average territory size of 25 acres per breeding pair, there were probably originally 2,200 to 2,500 Florida scrub-jay territories within Brevard County. The 1992-1993 statewide survey estimated that on federal lands within Brevard County, there were 860 pairs of Florida scrub-jays remaining; outside of federal lands, 276 breeding pairs of scrub-jays were present (Fitzpatrick *et al.* 1994). The figure on non-federal lands within Brevard County had dropped to 185 in 1999 (Toland 1999), illustrating aprecipitous decline of the scrub-jay population within the county. Part of this decline may be attributed to a possible rare epidemic in 1997-1998. A total of 1,620 acres of scrub habitat have been purchased (outside federal ownership) for preservation by Brevard County EEL, the St. Johns River Water Management District (SJRWMD), and the Florida Department of Environmental Protection (FDEP); 2,500 acres more of potential scrub-jay habitat are proposed for acquisition by EEL and the SJRWMD (Toland 1999). All of these parcels need extensive restoration and management to obtain maximum usage by scrub-jays. Over the last several years, an extensive effort to restore and manage these parcels has been undertaken by EEL, the SJRWMD, and FDEP (A. Birch, pers. comm.).

In some areas of the range of the scrub-jay, it appears that the 1992-1993 state-wide census underestimated populations of scrub-jays, especially in areas where little was known about the status of the species. The state-wide census in 1992-1993 estimated about 145 pairs of scrubjays remained within Sarasota County (Fitzpatrick *et al.* 1994), although Christman (2000) found 196 pairs of scrub-jays. Likewise, Miller and Stith (2002) documented 54 pairs of scrub-jays within the Deep Creek area of Charlotte County; while the state-wide census in 1992-1993 documented only 19 pairs (Fitzpatrick *et al.* 1994). Given that habitat has continued to degrade and development activity has increased in these areas, it is unlikely that these increased numbers reflect a population increase, but rather a greater effort in the survey process over that undertaken in 1992-1993 (Miller and Stith 2002). Two possible reasons that the 1992-1993 state-wide census underestimated some populations are (1) there was inadequate time and/or resources to survey poorly-known areas and (2) scrubby flatwoods were often overlooked because surveyors relied on soil maps, which are not reliable predictors of where scrubby flatwoods occur.

Stith (1999) utilized a spatially explicit individual-based population model developed specifically for the Florida scrub-jay to complete an rnetapopulation viability analysis of the species. The species' range was divided into 21 metapopulations demographically isolated from each other. Metapopulations are defined as collections of relatively discrete demographic populations distributed over the landscape; these populations are connected within the metapopulations through dispersal or migration (National Research Council 1995). A series of simulations were run for each of the 21 metapopulations based on different scenarios of reserve design ranging from the minimal configuration consisting of only currently protected patches of scrub (no acquisition option) to the maximum configuration, where all remaining significant scrub patches were

acquired for protection (complete acquisition option). The assumption was made that all areas that were protected were also restored and properly managed.

Results from Stith's (1999) simulation model included estimates of extinction, quasi-extinction (the probability of a scrub-jay metapopulation falling below 10 pairs), and percent population decline. These were then used to rank the different state-wide metapopulations by vulnerability. The model predicted that five metapopulations (NE Lake, Martin, Merritt Island, Ocala National Forest, and Lake Wales Ridge, see Figure I) have low risk of quasi-extinction. Two of the five (Martin and NE Lake), however, experienced significant population declines under the "no acquisition" option; the probability for survival of both of these metapopulations could be improved by more acquisitions.

Eleven of the remaining 21 metapopulations were shown to be highly vulnerable to quasi- extinction if no more habitat was acquired (Central Brevard, N Brevard, Central Charlotte, NW Charlotte, Citrus, Lee, Levy, Manatee, Pasco, St. Lucie, and W Volusia). The model predicted that the risk of quasi-extinction would be greatly reduced for 7 of the 11 metapopulations (Central Brevard, N Brevard, Central Charlotte, NW Charlotte, Levy, St. Lucie, and W Volusia) by acquiring all or most of the remaining scrub habitat. The model predicted that the remaining four metapopulations (Citrus, Lee, Manatee, and Pasco) would moderately benefit if more acquisitions were made.

Stith (1999) classified two metapopulations (S Brevard and Sarasota) as moderately vulnerable with a moderate potential for improvement; they both had one or more fairly stable subpopulations of scrub-jays under protection, but the model predicted large population declines. The rest of the metapopulations could collapse without further acquisitions, making the protected Subpopulations there vulnerable to epidemics or other catastrophes.

Three of the metapopulations evaluated by Stith (1999) (Flagler, Central Lake, and S. Palm Beach) were classified as highly vulnerable to quasi-extinction and had low potential for improvement, since little or no habitat is available to acquire or restore.

Analysis of the Species/Critical Habitat Likely to be Affected

The Florida scrub-jay's status since its listing in 1987 has not improved. The above analysis clearly shows two items that are essential for recovery of this species: (1) additional purchase of scrub lands for preservation in key areas and (2) restoration and management of publicly-owned scrub lands already under preservation. Without both, it is unlikely that recovery can be achieved.

SOUTHEASTERN BEACH MOUSE

Species/Critical Habitat Description

The southeastern beach mouse was listed as a threatened species under the Act in 1989 (54 FR 20598). Critical habitat was not designated for this subspecies.

Life History/Population Dynamics

The following account is from the South Florida Multi-Species Recovery Plan. Southeastern Beach Mouse Chapter (U.S. Fish and Wildlife Service 1999) and includes minor additions and changes to update the information.

Taxonomy
Peromyscus polionotus is a member of the order Rodentia and family Cricetidae. The southeastern beach mouse

(SEBM) is one of 16 recognized subspecies of oldfield mice P. *polionotis* (Hall 1981); it is one of the eight of those subspecies that are called beach mice. The SEBM was first described by Chapman (1889) as *Hesperomys niveiventris*. Bangs (1898) subsequently placed it in the genus *Peromyscus*, and Osgood (1909) assigned it the subspecific name P. *polionotus niveiventris.*

Description

The SEBM is the largest of eight recognized subspecies of beach mice, averaging 139 mm in total length (range of 10 individuals = 128 to 153 mm), with a 52 mm tail length (Osgood 1909; Stout 1992). Females are slightly larger than males. These beach mice are slightly darker in appereance than some othersubspecies of beach mice, but paler than inland populations iof *P. polionotus* (Osgood 1909). Southeasternbeach mice have pale, buffy coloration from the back of their head to their tail, and their underparts are white. The white hairs extend up on their flanks, high on their jaw, and within 2 to 3 mm of their eyes (Stout 1992). There are no white below. Juvenile P. *p. niveiventris* are more grayish in coloration thatn adults; otherwise they are similar in appearnace (Osgood 1909).

Habitat

Essential habitat of the SEBM is the sea oats (*Uniola paniculata*) zone of primary coastal dunes (Humphrey and Barbour 1981; Humphrey *et al.* 1987; Stout 1992). This subspecies has also bwwn reported from sandy areas of adjoining coastal strand/scrub vegetation (Extine 19810; Extine and Stout; 1987; Rich *et al.* 1993). Which refers to a transition zone between the fore dune and the inland plant community (Johnson and Barbour 1990). Beach mouse habitat is heterogeneous, and distributed in patches that occur in a narrow band along Floirda's coast, structure and composition of the vegetative comminities that form the habitate can change dramatically over distances of only a few meters.

Primary dune vegetation described from SEBM habitate includes sea oats, dune panic grass (*Panicum amarum)*, railroad vine (*Ipomaea pes- caprae)*, beach morning glory)*Ipomeaea stoelonifera),* salt meadow cordgrass (*Spartina patens*), lamb's quarters (Chenopodium album), saltgrass *(Distichlis spicata)*, and camphor weed (*Heterotheca subazillaris)* (Extine 1980). Coastal strand and inland vegetation is more diverse, and can include beach tea (*Croton punctatus),* prickly pear cactus (*Opuntia humifusa)*, saw palmetto (*Serenoa repens)*, wax myrtle (*Myrica cerfera),* rosemary (*Ceratiola ericoiodes)*, sea grape *(Coccoloba uvifera*), oaks *(Quercus sp.)* and sand pine (*Pinus clausa)* (Extine and Stout 1987). Extine (1980) observed this subspcies as fas as 1 km inland on Merritt Island; he concluded that the dune scrub communities he found in represent only marginal habitat for the SEBM. SEBM have been documented in coastal scrub several km from the beach habitat at Kennedy Space Center/Merritt Island NWR and CCAFS (Stout, personal communication, 2004). Exdtine (1980) and Extine and Stout (1987) reported that the SEBM showed a preference for areas with clumps of palmetto, sea grape, and expanses of open sand.

Within their dune habitat, beach mice construct burrows to use as refuges, nesting sites, and food storage areas. Burrows of *P. polionotus,* in general, consist of an entrance tunnel, nest chamber, and escape tunnel. Burrow entrances are usually placed on the sloping side of a dune at the base of a shrub or clump of grass. The nest chamber is formed at the end of the level portion of the entrance tunnel at a depth of 0.6 to 0.9m, and the escape tunnel rises from the nest chamber to within 2.5 cm of the surface (blair 1951). A beach mouse may have as many as 20 burrows within its home range. They are also known to use old burrows constructed by ghost crabs (*Ocypode quadrata*).

Foraging

Beach mice typically feed on seeds of sea of sea oats and dune oanic grass (Blair 1951). The SEBM probably also eats the seeds of other dune grasses, railroad vine, and prickly pear cactus. Although beach mice prefer the seeds of sea oats, these seeds are only available as food after they have been dispersed by the wind. Beach mice also eat small invertebrates, especially during late spring anmd early summer when seeds are acarce (Ehrhardt 1978). Beach mice will store food in their burrows.

Behavior

P. polionotus is the only member of the genus that digs an extensive burrow for refuge, nesting, and food storage (Ehrhart 1978). To dig the burrow, the mouse assumes a straddling position and throws sand back between the hind legs with the forefeet. The hind feet are then to kick sand back while the mouse backs slowly up and out of the borrow (Ivey 1949). Burrows usually contain multiple entrances, some of which are used as escape tunnels. When mice are disturbed in their burrows, they open escape tunnels and quickly flee to another burrow or to other cover (Ehrhart 1978). Beach mice, in general, are nocturnal. They are more active under stormy conditions or moonless nights and less active on moonlit nights. Movements are primarily for foraging, breeding, and burrow maintenance. Extine and Stout (1987) reported movements of the SEBM between primary dubne and interior scrub o nMerrtitt Island, nad concluded that their home ranges overlap and can reach high densities in their preferred habitats.

Reproduction and Demography

Studies on *Peromyscus* species in peninsular Floirda suggest that these species may achieve greater densities and undergo more significant population fluctuations than their temperate relatives, partially because of their extended reproductive season (Bigler and Jenkins 1975). Subtropical beach mice can reproduce throughout the year; however their peak reproductive activity is generally during late summer, fall, and early winter. Extine (1980) reported peak reproductive activity for P. p. *niveiventris* on Merritt Island during Augyust and September, based on external characterisitics of the adults. This peak in the timing and intensity of reproductive activity was laos correlated to the subsequent peak in the proportion of juveniles in the population in early winter (Extine 1980). This patten is typical of other beach mice as well (Rave and Holler 1992).

Sex rations in beach populations are generally 1:1 (Extine 1980; Rave and Holler 1992). Blair(1951) indicated that beach mice are monogamous; once a pair is mated they tend to remian togetheruntil death. He also found, however, that some adult mice of each sex show no desire to pair. Nests of beach mice are constructedin the nest chamber of their burrows, a spherical cavity about 4 to 6 cm in diameter. The nest comprises about one fourth of the size of the cavity and is composed of sea oat roots, stems, leaves and the chaffy parts of the panicles (Ivey 1949).

The reproductive potential of beach mice is generally high (Ehrhardt 1978). In capavity, beach mice arecapable pf producing 80 or more in there lifetime, aqnd producing litters regualrly at 26-day intervals (Bowen 1968). Litter size of beach mice, in general, ranges from two to seven, with an average of four. Beach mice reproductive maturity as early as 6 weeks of age (Ehrhart 1978).

Population Dynamics

Status and Trends

The distrubution of the beach mouse is limited due to modification and destruction of its coastal habitats. On the Atlantic coast of Florida, the Anatasia Island beach mouse (*P. p. phasma)* and the SEBM were federally listed as endangered and threaten, respectively, in 1989 (54 FR 20602). One additional Atlantic coast subspecies, the pallid beach mouse (*P. p. decoloratus),* was formerly reported from two sites in Volusia county, but extensive surveys provide substantial evidence that this subspecies is extinct (Humphrey and Frank 1992).

The distribution of the SEBM has declined sighificantly, particularly in the southern part of its range. Historically, it was reported to occur along about 280 km of Florida's central and southeast Atlantic coast from Ponce (Mosquito) Inlet, Volusia County, to Hollywood Beach, Broward County (Hall 1981). Bangs (1898) reported it as exteremely abundant on all the beaches of the eat peninsula from Palm Beach at least to Mosquito (Ponce) Inlet. During the 1990s, the SEBM was reported only from Volusia County (Canaveral National Seashore); in Brevard County (Canaveral National Seashore, Kennedy Space Center/Merritt Island NWR, and CCAFS); a few localities in Indian River County (Sebastian Inlet SRA, Treasure Shores Park, and several private properties), and St. Lucie County (Pepper Beach County Park and Fort Pierce Inlet SRA) (Humphrey

et al. 1987; Robson 1989; Land Planning Group, Inc.,1991; Humphrey and Frank 1992; U.S. Fish and Wildlife Service 1993).

Populations of the SEBM are still found on the beaches of Canaveral National Seashore, Merritt Island NWR, and CCAFS in Brevard County, all on federally protected lands. In April 2002, a population of SEBM was documented at the Smyrna Dunes Park, at the north end of New Smyrna Beach (A. Sauzo, personal communication, 2004). Populations from both sides of Sebastian Inlet appear to be extirpated (A. Bard, personal communication, 2004).

The status of the species south of Brevard County is currently unknown. The surveys done during the mid-1990s indicate the distribution of this subspecies in the counties south of Brevard was severely limited and fragmented. There are not enough data available to determine population trends for these populations. These surveys revealed that it occurred only in very small numbers where it was found. In Indian River County, the Treasure Shores Park population experienced a significant decline in the 1990s. and it is uncertain whether populations still exist at Turtle Trail or adjacent to the various private properties (D. Jennings, personal communication, 2004). Trapping efforts documented a decline from an estimated 300 individuals down to numbers in the single digits. No beach mice were found during surveys in St. Lucie County and it is possible that this species is extirpated there. The SEBM no longer occurs at Jupiter Island, Palm Beach, Lake Worth, Hillsboro Inlet or Hollywood Beach (U.S. Fish and Wildlife Service 1999).

The primary reason for the significant reduction in the range of the SEBM is the loss and alteration of coastal dunes. Large-scale commercial and residential development on the coast of Florida has eliminated SEBM habitat in the southern part of its range. This increased urbanization has also increased the recreational use of dunes, and harmed the vegetation essential for dune maintenance. Loss of dune vegetation results in widespread wind and water erosion and reduces the effectiveness of the dune to protect other beach mouse habitat. In addition to this increased urbanization, coastal erosion is responsible for the loss of the dune environment along the Atlantic coast, particularly during tropical storms and hurricanes. The extremely active 2004 hurricane season had a pronounced effect on Florida's Atlantic coast beaches and beach mouse habitat.

The encroachment of residential housing onto the Atlantic coast also increases the likelihood of predation by domestic cats and dogs. A healthy population of SEBM on the north side of Sebastian Inlet SRA in Brevard County was completely extirpated by 1972, presumably by feral cats (A. Bard, personal communication 2004). Urbanization of coastal habitat could also lead to potential competition of beach mice with house mice and introduced rats.

Beach mice along the Gulf Coasts of Florida and Alabama generally live about nine months (Swilling2000). Field trapping research indicates that 68 percent (average) of mice alive in one month will survive to the next month. Actual survival rates indicate that 18.5 to 87 percent of individuals survive no more than four months and some mice live between 12 and 20 months (Blair 1951; Rave and Holler 1992). Holler *et al.* (1997) found that 44.26 percent of beach mice captured for the first time survived to the next season (winter, spring, summer, and fall). The mean survival rate for mice captured for a second time to subsequent capture was higher (53.90 percent). More than ten percent of mice survived three seasons after first capture, and four to eight percent survived more than one year after initial capture.

Mice held in captivity by Blair (1951) and at Auburn University (Holler 1995) have lived three years or more.

Analysis of the Species/Critical Habitat Likely to be Affected

The southeastern beach mouse was listed as an endangered species primarily because of the fragmentation, adverse alteration and loss of habitat due to coastal development. The above analysis shows three items that are essential for recovery of this species: (1) purchase of coastal dune habitat for preservation; (2) removal of

predation or competition by animals related to human development (cats and house mice); and (3) increase the regulations regarding coastal development.

Status of the Species in the Action Area

The southeastern beach mouse is found along the entire reach of coastline on CCAFS in addition to the KSC and Cape Canaveral National Seashore. The known distribution is a result of cursory surveys and intermittent trapping involving different construction projects. There has not been a systematic trapping study done in order to determine the status throughout its range on these Federal lands. The species is found within the action area. However as reported in the Draft EA, the *Report on southeastern beach mouse (Peromyscus polionotus niveiventris) habitat occupancy survey on Cape Canaveral Air Force Station dated February 2013,* used tracking, modeling, and probability methods over a three month period to determine "absence-presence", which included the beach area of the SpaceX Proposed Action location. The report found that one station of the study (Station 21) located near the beach adjacent to LC-13 reported beach mice exist in the area. In support of the EA and associated BA, a limited beach mouse survey was accomplished between June 8 and June 12, 2014. The survey used the standard 200 Trap-night method approved by the FWCC, and the USFWS. The 50 Single Sherman live traps were placed at locations along the western side of the approximate 2000 foot primary beach dune area, and scrub area. Traps were opened in the late afternoon, baited with oats, and checked for captures the following morning. During the four nights of trapping a total of seventeen (17) southeastern mice were caught and released. All mice trapped were generally closer to the dune crown area than the palmetto scrub area further inland.

Factors affecting species environment within the action area

Federal actions have taken place within the action area that has impacted the southeastern beach mouse. These projects resulted in incidental take through section 7 of the Act. The impacts associated with these projects resulted in the loss of occupied habitat within the action area. However, the adverse effects of the southeastern beach mouse from these projects were off-set through on-site preservation and improvement of scrub habitat; resulting in a net increase in scrub habitat under active management. On CCAFS, southeastern beach mice have been located in the scrub habitat and further inland than in the coastal strand. Improvements to the management of scrub have increased the amount of habitat used by the southeastern beach mouse.

EASTERN INDIGO SNAKE

Species/Critical Habitat Description

The eastern indigo snake is one of eight subspecies of a primarily tropical species; only the eastern indigo and the Texas indigo *iDrymarchon corals erebennusy* occur within the United States (U.S. Fish and Wildlife Service 1982). The eastern indigo snake is isolated from the Texas indigo snake by more than 600 miles (Moler 1992). The eastern indigo snake is the longest snake in North America, obtaining lengths of up to 104 inches (Ashton and Ashton

1981). Its color is uniformly lustrous-black, dorsally and ventrally, except for a red or cream-colored suffusion of the chin, throat, and sometimes the cheeks. Its scales are large and smooth (central 3-5 scale rows are lightly keeled in adult males) in 17 scale rows at midbody. Its anal plate is undivided. Its antepenultimate supralabial scale does not contact the temporal postocular seales.

The eastern indigo snake was listed as a threatened under the Act in 1978 (43 FR 4621). No critical habitat has been designated for this species; therefore none will be affected by the proposed project.

Life History/Population Dynamics

Historically, the eastern indigo snake occurred throughout Florida and into the coastal plain of Georgia, Alabama, and Mississippi (Loding 19-22; Haltom 1931; Carr 1940; Cook 1954; Diemer and Speake 1983; Moler 1985a). It may have occurred in South Carolina, but its occurrence there cannot be confirmed. Georgia and Florida currently support the remaining endemic populations of eastern indigo snake (Lawler 1977). In I 982, only a few populations remained in the Florida panhandle, and the species was considered rare in that region. Nevertheless, based on museum specimens and field sightings, the eastern indigo snake still occurs throughout Florida, even though they are not commonly seen (Moler 1985a).

In south Florida, the eastern indigo snake is thought to be widely distributed and probably more abundant than in the northern limits of the range, especially compared to the low densities found in the panhandle of Florida. Given their preference for upland habitats, indigos are not found in great numbers in wetland complexes of the Everglades region, even though they are found in pinelands and tropical hardwood hammocks in extreme south Florida (Steiner *et al.* 1983).

Indigo snakes also occur in the Florida Keys. They have been collected from Big Pine and Middle Torch Keys, and are reliably reported from Big Torch, Little Torch, Sumrnerland, Cudjoe, Sugarloaf, and Boca Chica Keys (Lazell 1989). Given the ubiquitous nature of the eastern indigo throughout the remainder of its range, it is likely that it also occurs on other Keys.

Over most of its range, the eastern indigo snake frequents a diversity of habitat types such as pine flatwoods, scrubby flatwoods, xeric sandhill communities, and tropical hardwood hammocks, edges of freshwater marshes, agricultural fields, coastal dunes, and human altered habitats. Eastern indigo snakes need a mosaic of habitats to complete their annual cycle. Interspersion of tortoise-inhabited sandhills and wetlands improves habitat quality for the indigo snakes (Landers and Speake 1980; Auffenberg and Franz 1982). Eastern indigo snakes require sheltered retreats from winter cold and desiccation (Bogert and Cowles 1947). Whenever the eastern indigo snake occurs in xeric habitats, it is closely associated with the gopher tortoise *(Gopherus polyphemusi,* the burrows of which shelter the indigo snakes from the winter cold and desiccating sandhills environment (Bogert and Cowles 1947; Speake *et al.* 1978; Layne and Steiner 1996). This dependence seems especially pronounced in Georgia, Alabama, and the panhandle of Florida, where the eastern indigo snake is largely restricted to the vicinity of the sandhill habitats occupied by gopher tortoises (Diemer and Speake 198 1; Moler 1985b; Mount1975). The high use ofxeric sandhill habitats throughout the northern portion of the eastern indigo's range can be attributed primarily to the availability of thermal refuge afforded by gopher tortoise burrows in the winter. No such refugia is widely available off of the sandhills regions of southern Georgia and northern Florida. In wetter habitats that lack gopher tortoises, eastern indigo snakes may take shelter in hollowed root channels, hollow logs, or the burrows of rodents, armadillos (*Dasypus novemcinctusi,* or crabs (Lawler 1977; Moler 1985b; Layne and Steiner 1996).

In the milder climates of central and southern Florida, eastern indigo snakes exist in a more stable thermal environment, where the availability of thermal refugia may not be as critical to the snake's survival, especially in extreme southern Florida. Throughout peninsular Florida, the eastern indigo snake can be found in all terrestrial habitats, which have not suffered high urban development. They are especially common in hydric hammocks throughout this region (Moler 1985a). In central and coastal Florida, eastern indigo snakes are typically found in the state's high sandy ridges. In extreme south Florida, these snakes are mainly found in pine flatwoods, pine rockland, tropical hardwood hammock habitats, and in most other undeveloped areas (Kuntz 1977). Eastern indigo snakes also use some agricultural lands (e.g., citrus) and various types of wetlands (Layne and Steiner 1996).

Even though thermal stresses may not be a year-round limiting factor in southern Florida, eastern indigo snakes seek and use underground refugia. On the sandy central and coastal ridges of south Florida, indigo snakes use gopher tortoise burrows (62 percent) more than other underground refugia (Layne and Steiner

1996). Other underground refugia used by indigo snakes include burrows of armadillos, cotton rats *(Sigmodon hispidus),* and land crabs; burrows of unknown origin; natural ground holes; hollows at the base of trees or shrubs; ground litter;

trash piles; and in the crevices of rock-lined ditch walls (Layne and Steiner 1996). These refugia sites are used most frequently where tortoise burrows are not available, principally in the low• lying areas off of the central and coastal ridges.

Smith (1987) radio-tagged hatchling, yearling, and gravid eastern indigo snakes and released them in different habitat types on St. Marks National Wildlife Refuge in Wakulla County, Florida, in 1985 and 1986. Smith monitored the behavior, habitat use, and oviposition sites selected by gravid female snakes and concluded that the diverse habitats, including high pineland, pine-palmetto flatwoods, and permanent open ponds were important for the eastern indigo snake's seasonal activity. In this study, habitat use also differed by age-class and season; adult indigo snakes often used gopher tortoise burrows during April and May, while juveniles used root and rodent holes. The indigo snakes used gopher tortoise burrows for oviposition sites in high pineland areas, but stumps were chosen in flatwoods and pond edge habitats (Smith 1987).

Monitoring of radio-fitted indigo snakes on the central ridge of south Florida indicate that snakes in this part of the state use a wide variety of natural, disturbed, and non-natural habitat types throughout the year. On the ridge itself, indigos favor mature oak phase scrub, turkey oak sandhill, and abandoned citrus grove habitats, while snakes found off the sandy ridges use flatwoods, seasonal ponds, improved pasture, and active and inactive agricultural lands. There was no apparent selection for one habitat type over another as the use of habitats closely reflected the relative availability and distribution of the vegetation types in these areas (Layne and Steiner 1996).

In extreme south Florida (the Everglades and Florida Keys), indigo snakes are found in tropical hardwood hammocks, freshwater marshes, abandoned agricultural lands, coastal prairie, mangrove swamps, and human altered habitats (Steiner *et al.* 1983). It is suspected that they prefer hammocks and pine forests since most observations occur there, and use of these areas are disproportionate compared to the relatively small total area of these habitats (Steiner *et al.* 1983).

Reproduction: Most information on the reproductive cycle of the eastern indigo snake is from data collected in northern Florida. Here, breeding occurs between November and April, and females deposit four to twelve eggs during May or June (Moler 1992). Speake (1993) reported an average clutch size of 9.4 for 20 captive bred females. Young hatch in approximately three months, from late May through August. Peak hatching activity occurs during August and September, while yearling activity peaks in April and May. In this region, breeding extends from June to January, laying occurs from April to July, and hatching occurs during mid-summer to early fall (Layne and Steiner 1996).

Female indigo snakes can store sperm and delay fertilization of eggs; there is a single record of a captive snake laying five eggs (at least one of which was fertilized) after being isolated for more than four years (Carson 1945). There is no information on how long eastern indigo snakes live in the wild; in captivity, the longest an eastern indigo snake lived was 25 years, 11 months (Shaw 1959).

Feeding: The eastern indigo snake is an active terrestrial and fossorial predator that will eat any vertebrate small enough to be overpowered. Layne and Steiner (1996) documented several instances of indigos flushing prey from cover and then chasing it. Though unusual, indigo snakes may also climb shrubs or trees in search of prey. An adult eastern indigo snake's diet may include fish, frogs, toads, other snakes, lizards, turtles, turtle eggs, juvinile gopher tortoises, small alligators, birds, and small mammals (Keegan 1944; Babis 1949;Kochman 1978; Steiner *et al* 1983). Juvenile indigo snakes eat mostly invertebrates (Layne and Steiner 1996).

Movements: Indigo snakes range over large areas and into various habitats throughout the year, with most activity occurring during summer and fall (Smith 1987; Moler 1985b; Speake 1993). The average home range of an eastern indigo snake is 12 acres during the winter (December - April), 106 acres during late spring early summer (May-July), and 241 acres during late summer and fall (August - November) (Speake *et al.* 1978). Adult male eastern indigo snakes have larger home ranges than adult females and juveniles; their home range may encompass as much as 553 acres in the summer (Moler 1985b; Speake 1993). By contrast, a gravid female may use from 4 to 106 acres (Smith 1987). These estimates are comparable to those found by Layne and Steiner (1996) in south central Florida, who determined adult male home ranges average about 183 acres, while adult females average about 42 acres.

Status and Distribution

As stated earlier, the eastern indigo snake was listed based on population decline caused by habitat loss, over-collection for the pet trade, and mortality from gassing gopher tortoise burrows to collect rattlesnakes (Speake and Mount 1973; Speake and McGlincy 1981). At the time of listing, the main factor in the decline of the eastern indigo snake was attributed to exploitation for the pet trade. As a result of effective law enforcement, the pressure from collectors has declined, but still remains a concern (Moler 1992).

The eastern indigo snake utilizes a majority of habitats available, but tends to prefer open, undeveloped areas (Kuntz 1977). Because of its relatively large home range, this snake is especially vulnerable to habitat loss, degradation, and fragmentation (Lawler 1977; Moler 1985b). Lawler (1977) noted that eastern indigo snake habitat had been destroyed by residential and commercial construction, agriculture,and timbering. He stated that the loss of natural habitat is increasing because of these threats in Floirda and that indigo snake habitat is being lost at a rate of five percent per year. Low-denisty residential housing is alos a potential threat to the species, increasing the likelihood that the snake will be killed by property owners and domestic pets. Extensive tracts of wild land are the most important refuge for large numbers of eastern indigo snakes (Diemer and Speake 1981; Moler 1985b).

Additional human population growth will increase the risk of direct mortality of the eastern indigo snake from property owners and domestic animals. Pesticides that bioaccumulate through the food chain may present a potential hazard to the snake as well pesticide use on crops or for forestry/silviculture would propose a pulse effect to the indigo snake (Speake 1993). Direct exposure to treated areas and secondary exposure by ingestion of contaminated prey could occur. Secondary exposure to rodenticides used to control black rats may also occur (Speake 1993).

The wide distribution and territory size requirements of the eastern indigo snake makes evaluation of status and trends very difficult. We believe that activities such as collecting and gassing have been largely abated through effective enforcement and protective laws. However, despite these apparent gains in indigo snake conservation, we believe that the threats described above are acting individually and collectively against the eastern indigo snake. Though we have no quantitative data with which to evaluate trends of the eastern indigo snake in Florida, we surmise that the population as a whole is declining because of continued habitat destruction and degradation. Natural communities continue to be altered for agriculture, residential, and commercial purposes, most of which are incompatible with the habitat needs of the eastern indigo snake (Kautz 1993). Habitat destruction and alteration is probably most substantial along the coasts, Keys, and high central ridges of southcentral Florida, where human population growth is expected to continue to accelerate. Agricultural interests (principally citrus) continue to destroy large expanses of suitable natural habitat in south Florida.

Even with continued habitat destruction and alterations, indigo snakes will probably persist in most localities where small, fragmented pieces of natural habitat remain. Tracts of appropriate habitat of a few hundred to several thousand acres may be sufficient to support a small number of snakes. Unfortunately, we believe that current and anticipated habitat fragmentation will result in a large number of isolated, small groups of indigo

snakes. Fragmented habitat patches probably cannot support a sufficient number of indigo snakes to ensure viable populations.

One of the primary reasons for listing of the species was the pressure on wild populations caused by over-collecting for the pet trade and commerce. Since the listing of the species, private collectors have engaged in a very active captive breeding program to fulfill the desires of individuals wanting specimens for personal pets. The Service controls the interstate commerce of the species via a permit program. The Service believes that this has significantly reduced the collection pressures on the species.

Analysis of the Species/Critical Habitat Likely to be affected

The eastern indigo snake was listed in January 1978 as a threatened species primarily due to habitat loss and to over-collecting for the pet trade. The above analysis shows two items that are essential for recovery of this species: (1) acquire and/or manage habitat to maintain viable populations and (2) study their movement, food habitats, and population ecology.

ENVIRONMENTAL BASELINE

Action Area

The action area for this biological opinion is defined as all developed and undeveloped areas within, contiguous, and immediately adjacent to the project footprint at LC-13, as well as the proposed scrub-jay compensation site.

Status of the Species in the Action Area

Florida scrub-jay: The Florida scrub-jay is found within much of the scrub habitat (generally less than 10 feet in height) on CCAFS in addition to the Kennedy Space Center (KSC) and Cape Canaveral National Seashore (CNS). The known distribution is a result of annual surveys conducted by CCAFS 45 SW staff. As reported in the BA, the 2013 census resulted in 138 groups with a total of 476 birds. This data represented a decrease of 14 families from the 2013 census, but an increase of 78 birds. In 2009 and 2013 the closest scrub-jay families to LC-13 were north near LC-14. Scrub-jay families or birds did not appear to be on the site in May of 2014. The Florida scrub-jay population on CCAFS was approximately 391 birds (126 groups) in 2007. In 2005, the scrub-jay census resulted in 308 birds (103 groups of two or more birds and nine single birds). This represents a slight net increase in groups (6) from the 2004 breeding season. The population on CCAFS was approximately 276 birds (99 groups of two or more birds and seven single birds) in 2003-2004. The number of jays decreased slightly (9 percent) from the previous year. The trend in population size over the last ten years has been downward, with an occasional increase in numbers within the ten-year study. The smaller population size was partly due to low reproductive success in 2002-2003, when breeding pairs fledged at a rate of 40 percent and 44 percent, respectively. Significant numbers of young were lost after they fledged (about 50 percent), likely due to predation. Adult survivorship was 74 percent between 2003 and 2004, which is about average for the eight years of study. Breeder survivorship was slightly higher than average (81 percent), and juvenile survivorship was above average (68 percent). Forty-seven percent of the 91 nesting groups produced young, yielding 73 juveniles by the end of the 2003-2004 breeding season (Stevens and Knight 2004). The populations of scrub-jays occurring on CCAFS are a subset of the larger MINWR/KSC/ CCAFS metapopulation.

The current INRMP for CCAFS has a goal of 300 breeding pairs of scrub-jays. Recent conversations with representatives from the USAF and USFWS regarding recovery actions for the Florida scrub-jay resulted is USAF natural resource managers categorizing CCAFS habitat into good, fair, and poor scrub habitat that will be managed as scrub-jay habitat. Additionally USFWS and the Florida Fish and Wildlife Conservation

Commission (FWC) indicated that the MINWR/KSC/CCAFS population of scrub-jays must be maintained at 600 breeding pairs for conservation of the species. At the time, the USAF was asked to determine how many breeding pairs they could support based on funding and mission constraints knowing that the 300 breeding pairs was probably not possible to achieve. The USAF determined the amount of scrub/potential scrub habitat available, and using the percentage that could be in optimal condition at any given time (50%-70%) and the average territory size of 25 acres/group, calculated that CCAFS could support 170-237 breeding pairs. For the purposes of providing USFWS a number that could be used in recovery, USAF natural resource managers used 200 breeding pairs as the new goal.

Southeastern beach mouse: The southeastern beach mouse is found along the entire reach of coastline on CCAFS in addition to the KSC and Cape Canaveral National Seashore. The known distribution is a result of cursory surveys and intermittent trapping involving different construction projects. Between June 8 and June 12, 2014, a "200 trap-night" limited survey was accomplished to asses if the southeastern beach mouse was present within the project area. That survey found that southeastern beach mice are present in the primary beach dune crown and western side of the dune. The area extends between approximately 20 and 80 feet west of the dune crown, approximately 5.4 acres.

Eastern indigo snake: The eastern indigo snake is likely to occur within the boundaries of the project site due to the presence of suitable habitat, although none have been seen. The eastern indigo snake standard protection measures will be used during the construction of the project.

Factors Affecting Species' Environment within the Action Area

This analysis describes affecting the environment for scrub-jays, southern beach mice, and eastern indigo snakes in the action area. There are no State, tribal, local or private actions affecting the species or that will occur contemporaneously with this consultation. Federal actions have taken place within the action areas that have impacted Florida scrub-jays, southeastern beach mice, and eastern indigo snakes. These projects sometimes resulted in incidental take anticipated through section 7 of the Act. The impacts associated with some of these projects resulted in the loss of occupied habitat suitable for occupation within the action area.

Prescribed burning and restoration of overgrown scrub habitat for the benefit of the scrub-jay have occurred and are ongoing on CCAFS. CCAFS continues to pursue its goal of increasing the breeding pairs of scrub-jays, as outlined in their INRMP. The INRMP identifies burning and/or mechanical management of 500 acres per year; however, in recent consultations with USFWS, a consensus was reached that an average of 300 acres per year over a rolling 10-year time frame is more realistic. This goal may be achieved more quickly if existing burning constraints are reduced in the future. CCAFS has a prescribed burn working group that deals with issues of burn restrictions on CCAFS. This group meets regularly at CCAFS. Federal actions have taken place within the action area that has impacted the Florida scrub-jay. The impacts associated with these projects resulted in the loss of occupied habitat within the action area. However, the adverse effects of the Florida scrub-jay from these projects were off-set through on-site addition, preservation, and improvement of scrub habitat; resulting in a net increase in scrub habitat under active management. On CCAFS, improvements to the management of scrub have increased the amount of habitat used by the Florida scrub-jay, eastern indigo snake, and possibly southeastern beach mouse.

EFFECTS OF THE ACTION

This section includes an analysis of the direct effects of the proposed action on the species and its interrelated and interdependent activities. To determine whether the proposed action is likely to jeopardize the continued existence of threatened or endangered species in the action area, we focus on consequences of the proposed action that affect rates of birth, death, immigration, and emigration because the probability of extinction in plant and animal populations is most sensitive to changes in these rates.

Factors to Be Considered

The effects of the proposed project of the Florida scrub-jay, southeastern beach mouse, and eastern indigo snake may occur as direct and indirect effects.

Direct Effects

The LC-13 area clearing and construction activities associated with the Proposed Action may result in the direct "take" of Florida scrub-jays, eastern indigo snakes, and southeastern beach mice as a result of permanent loss of up to 50 acres of overgrown scrub habitat. At the present time there is no evidence that this area is currently occupied by scrub-jays. The probability and level of incidental take is dependent upon the number of scrub-jays, southeastern beach mice, and eastern indigo snakes within the action area; their ability to disperse; and the amount and distribution of available suitable habitat. It is possible that as land clearing proceeds, they will move away from the site; however, the Service anticipates that "take" will occur

The proposed activity will result in the direct permanent loss of approximately 50 acres of scrub habitat. The proposed project will impact unoccupied scrub-jay habitat adjacent to known scrub-jay territories. The proposed project may impact occupied southeastern beach mouse habitat along the approximately 2,000 linear feet of the western part of the main dune, approximately 5.4 acres. Since land clearing would proceed adjacent to existing southeastern beach mouse burrows and habitat, the Service anticipates that "take" may occur. Similar direct effects are expected for any eastern indigo snakes occurring within the project site. Impacts to the three species will be minimized by the restoration of 100 acres of potential scrub-jay, southeastern beach mouse, and eastern indigo snake habitat within LMA 33 on CCAFS. Impacts would also be minimized since over time approximately 22 acres of land east of the ditch may revert back to species habitat..

American alligators, sea turtle, piping plovers, and the red knot are not expected to be directly affected by the habitat removal construction activities.

Noise related effects caused by clearing and construction activities, and Falcon vehicle landing associated with the Proposed Action may result in direct effects to the Florida scrub-jays, eastern indigo snakes, and southeastern beach mice. Effects would include disruption of normal activities due to noise and ground disturbances. However these effects would be short-term and would elicit a "startle response" to avoid the noise. This would help the Florida scrub-jay, the eastern indigo snake and the southeastern beach mouse to avoid the threat and therefore, would not cause a negative impact to populations near the project area. Just as noise associated with rocket launches may startle many species within the CCAFS area, noise associated with landing, although much less intense, may do the same. Actual noise impact to wildlife is expected to be minimal. Additionally, current and past launch programs on CCAFS, including the Falcon 9, Atlas, the Titan, or the Delta launches have been documented to cause any animal mortality or significant impact to wildlife habitat on CCAFS (USAF 2013a). Anticipated sonic boom noise in the project area of 1 psf or less is expected to have very little effect on birds, other animals and marine turtles.

Indirect Effects

Indirect effects are caused by or result from the proposed action, are later in time, and are reasonably certain to occur. Indirect effects may occur outside of the area directly affected by the action. Indirect effects may include other Federal actions that have not undergone section 7 consultations, but will result from the action under consideration. The indirect effects will occur in two ways: (1) operation of the LC-13 landing pad and facilities will add traffic along roadways adjacent to occupied habitat, possibly resulting in scrub-jays and snakes being struck by vehicles or (2) proposed habitat restoration and management activities are expected to enhance scrub-jay dispersal when complete.

Dreschel *et al.* (1990), Fitzpatrick *et al.* (1991), and Mumme *et al.* (2000) provide the best scientific and commercial data on the likelihood of incidental take as the result of scrub-jays being killed by the vehicles. The only scientific documentation of road-kill mortality in Florida scrub-jays are from jays living in a territory immediately adjacent to a road, not from dispersing some unknown distance across a road to a new territory.

The eastern indigo snake has a low probability of being impacted by increased traffic on the roads. Since a portion of their suitable habitat will be impacted by the proposed development, the snakes may have to go elsewhere and cause them to cross roads which could result in road-kill mortality. Indirect effects are not expected for the southeastern beach mouse.

While American alligators and piping Plovers are not expected to be indirectly affected by the Proposed Actions, workers would be advised that alligators exist on CCAFS and may be in water-filled ditches.

Indirect effects from noise during vehicle landings, currently planned for one per month, are not expected for the Florida Scrub-jay, the eastern indigo snake, marine turtles, or the southeastern beach mouse.

Research has shown that female marine turtles will avoid highly illuminated beaches and postpone nesting. Artificial lights have also resulted in hatchling mortality as disoriented hatchlings move toward these light sources rather than the ocean. Potential indirect effects from light associated from construction and clearing activities are not expected since those activities would not occur at night. While a night landing event would be rare, limited short-term indirect effect may occur in a limited area as the landing vehicle descends to the landing pad.

CUMULATIVE EFFECTS

Cumulative effects include the effects of future State, local or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act.

CONCLUSION

After reviewing the current status of the Florida scrub-jay, southeastern beach mouse, and the eastern indigo snake, the environmental baseline for the action area, the effects of the proposed LC-13 area land clearing, and the cumulative effects, it is the Service's determination that the proposed landing of the SpaceX Falcon stage at LC-13 and all actions related, as proposed, is not likely to jeopardize the continued existence of the Florida scrub-jay, the southeastern beach mouse, and the eastern indigo snake. No critical habitat has been designated for the three species; therefore, none will be affected.

INCIDENTAL TAKE STATEMENT

Section 9 of the Act and Federal regulation under section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Harass is defined by the Service as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4)

and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measures described below are non-discretionary, and must be implemented by the agency so that they become binding conditions of any grant or permit issued to the applicant, as appropriate, in order for the exemption in section 7(o)(2) to apply.

The Federal agency has a continuing responsibility to regulate the activity that is covered by thisincidental take statement. If the agency (1) fails to assume and implement the terms and conditions or (2) fails to retain oversight to ensure compliance with these terms and conditions, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the agency must report the progress of the action and its impact on the species to the

Service as specified in the incidental take statement. (50 CFR 402.14(1) (3))

Sections 7(b) (4) and 7(o) (2) of the Act do not apply to the incidental take of listed plant species. However, protection of listed plants is provided to the extent that the Act requires a Federal permit for removal or reduction to possession of endangered plants from areas under Federal jurisdiction, or for any act that would remove, cut, dig up, or damage or destroy any such species on any State or in the course of any violation of a State criminal trespass law.

AMOUNT OR EXTENT OF TAKE ANTICIPATED

The Service has reviewed the biological information for the Florida scrub-jay s, information presented by the applicant's consultant, and other available information relevant to this action, and based on our review; incidental take in the form of harm or harassment is not anticipated for any families or individuals since they are found on the adjacent property and not within the proposed project site.

The Service expects the level of incidental take of southeastern beach mice and eastern indigo snakes will be difficult to determine for the following reasons: eastern indigo snakes are wide ranging and elusive; southeastern beach mice are elusive because of their burrowing habits; finding a dead or impaired specimen is unlikely; losses may be masked by predators removing dead or injured animals. The Service has reviewed the biological information for these species, information provided by representatives of the 45th SW, and has determined that incidental take in the form of harm or harassment is anticipated for any eastern indigo snakes utilizing the 50-acre area, and for any southeastern beach mice that live or forage within habitat that would be impacted by the proposed project.

If during the course of this action, the project description changes, this would represent new information requiring review of the reasonable and prudent measures provided. The Service will work with the 45th Space Wing and SpaceX to undertake a timely review and adjustment of those measures as warranted.

EFFECT OF THE TAKE

In the accompanying biological opinion, the Service determined that this level of anticipated take is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitat.

REASONABLE AND PRUDENT MEASURES

The Service believes the following reasonable and prudent measures are necessary and minimize impacts of incidental take of Florida scrub-jays, southeastern beach mice, and eastern indigo snakes.

Florida scrub-jay

1. Perform nesting surveys prior to any clearing activities. Avoid construction during the nesting season from March 1 through June 30, if applicable.

2. Notify the Service of any unauthorized take of Florida scrub-jays identified during the construction of the proposed facility.

3. Restore, maintain, and manage 100 acres of scrub habitat within LMU 33 by using mechanical cutting and prescribed burning.

4. Conduct scrub-jay monitoring in the restoration areas.

Southeastern beach mouse

1. Notify the Service of any unauthorized take of southeastern beach mice identified during the construction activity.

2. Avoid potential for southeastern beach mice to be injured or killed by heavy equipment and the destruction of burrows by hand-cutting in those areas being used by beach mice.

3. Re-vegetate east of the ditch using native plants such as grasses or sea oats.

Eastern indigo snake

1. Minimize impacts to eastern indigo snakes from heavy equipment by implementing the 2013 standard protection measures.
2. Only individuals with permits should attempt to capture the eastern indigo snakes. If an eastern indigo snake is held in captivity, it should be released as soon as possible in release sites approved by the Service on the CCAFS.

3. Notify the Service of any unauthorized take of eastern indigo snakes identified during the construction of the proposed facility.

TERMS AND CONDITIONS

To implement the above reasonable and prudent measures, the Service has outlined the following terms and conditions for incidental take. In accordance with the Interagency Cooperation (50 CFR 402), these terms and conditions must be complied with to implement the reasonable and prudent measures for incidental take:

Florida scrub-jay

1. Perform pre-construction nesting surveys and avoid construction and/or clearing in scrub-jay occupied areas during the nesting season from March 1 through June 30, if applicable.

2. Unauthorized take of scrub-jays associated with the proposed activity should be reported immediately by calling the Jacksonville Field Office of the U.S. Fish and Wildlife Service in Jacksonville at 904-731-3336. If a dead Florida scrub-jay is found on the project site, the specimen should be thoroughly soaked in water and frozen for later analysis of cause of death or injury.

3. SpaceX will restore, maintain, and manage 100 acres of scrub habitat within LMU 33 by using prescribed burning and mechanical means.

4. Conduct scrub-jay monitoring to demonstrate that the scrub-jays are using the restored area and this area is providing habitat for scrub-jays.

Southeastern beach mouse

1. If a dead southeastern beach mouse is found on the project site, the specimen should be thoroughly soaked in water and frozen, and the applicant should notify the Jacksonville Field Office immediately at (904) 731-3336. Care should be taken in handling sick or injured individuals and in the preservation of specimens in the best possible state for later analysis of cause of death or injury.

2. Hand-cut any vegetation requiring removal located in areas where beach mice were captured or observed during the pre-construction trapping event. Re-plant the area east of the ditch using native plants such as grasses or sea oats.

3. All construction work shall be conducted during daylight hours.

Eastern indigo snake

1. The 45 SW eastern indigo snake protection/education plan based on the 2013 Eastern Indigo Standard Protection Measures shall be provided to the proponent and for all construction personnel to follow.

2. Only an individual who has been either authorized by a section 10(a)(1)(A) permit issued by the Service, or designated as an agent of the State of Florida by the Florida Fish and Wildlife Conservation Commission for such activities, is permitted to come in contact with or relocate an eastern indigo snake.

3. If necessary, eastern indigo snakes shall be held in captivity only long enough to transport them to a release site; at no time shall two snakes be kept in the same container during transportation.

4. If a dead eastern indigo snake is found on the project site, the specimen should be thoroughly soaked in water and frozen, and the applicant should notify the Jacksonville Field Office immediately at (904) 731-3336. Care should be taken in handling sick or injured individuals and in the preservation of specimens in the best possible state for later analysis of cause of death or injury.

CONSERVATION RECOMMENDATIONS

Section 7(a) (1) of the Act directs Federal agencies to use their authority to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation

recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help carry out recovery plans, or to develop information.

1. Leave and use native scrub vegetation in landscaping around the retention areas and throughout the proposed project site.

2. In order for the Service to be kept informed of actions minimizing or avoiding adverse effects or benefiting listed species or their habitats, the Service requests notification of the implementation of any conservation measures.

REINITIATION OF SECTION 7 CONSULTATION

This concludes formal consultation on the action outlined in the request. As provided in 50 CFR Section 402.16, re-initiation of formal consultation is required when discretionary Federal agency involvement or control over the action has been retained and if: (1) the amount or extent of incidental take is exceeded, (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this biological opinion, (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this biological opinion, or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending re-initiation. The Service appreciates the cooperation of the Air Force during this consultation. We would like to continue working with you and your staff regarding the LC-13 landing pad area project. For further coordination please contact John Milio at (904) 731-3336 of this office.

Sincerely,

for Jay B. Herrington
Field Supervisor

cc: FWS, Region 4 (Atlanta)
FWC (Tallahassee)

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Appendix H
Florida State Historical Resource Division Archeological Response Letter
To USAF LC-13 Archeological Survey

FLORIDA DEPARTMENT of STATE

RICK SCOTT
Governor

KEN DETZNER
Secretary of State

Mr. Michael A. Blaylock
Chief, Environmental Conservation
45 CES/CEIE
1224 Jupiter Street, MS-9125
Patrick AFB, Florida 32925-3343

September 10, 2014

Re: DHR Project File No.: 2014-4037 / Received by DHR: August 26, 2014
A Cultural Resources Assessment Survey of the Proposed Falcon Vertical Landing Site, Cape Canaveral Air Force Station, Brevard County, Florida

Dear Mr. Blaylock:

Our office received and reviewed the above referenced report in accordance with Section 106 of the *National Historic Preservation Act of 1966* (Public Law 89-665), as amended in 1992, and *36 C.F.R., Part 800: Protection of Historic Properties*, and Chapter 267, *Florida Statutes,* for assessment of possible adverse impact to cultural resources (any prehistoric or historic district, site, building, structure, or object) listed, or eligible for listing, in the National Register of Historic Places (NRHP).

From June through August 2014, the 45th Space Wing Cultural Resources Manager (45 SW CRM) conducted an archaeological and historical survey of the proposed project area at LC-13 being affected by the vertical landing site for the Falcon first stage vehicle. 45 SW CRM completed this survey on behalf of the US Air Force. 45 SW CRM investigated three previously unrecorded archaeological sites (8BR3176-8BR3178), the LC-13 historic launch complex (8BR2198), and the LC-12 historic launch complex (8BR2320).

Angy's Scatters (8BR3176) is a 20th century domestic refuse scatter. The Atlas Missile Debris Site (8BR3177) is associated with a missile mishap on the LC-12 pad in September 1959. The integrity of this site is questioned, and 45 SW CRM concluded that it is possible this debris was moved here and is a secondary deposition. Canaveral Rose's Garden (8BR3178) is a coquina midden that contained no diagnostic artifacts. 45 SW CRM determined that these sites are ineligible for listing in the NRHP.

LC-13 (8BR2198) was previously determined by our office to be eligible for listing in the NRHP, however, the complex does not retain its historical integrity due to removal of the LC-13 Blockhouse (8BR2135). LC-12 (8BR 2320) was determined to be ineligible for the NRHP in 2009.

45 SW CRM determined that the proposed project will have no effect on cultural resources listed, or eligible for listing in the NRHP, or otherwise of archaeological, historical, or architectural significance. 45 SW CRM recommends that every effort is made to insure that LC-14, a NHL listed property, is protected from landing mishaps.

Based on the information provided, our office concurs with these determinations finds the submitted report to be complete and sufficient in accordance with Chapter 1A-46, *Florida Administrative Code*.

If I can be of any further help, or if you have any questions about this letter, please feel free to contact me at Sarah.Liko@DOS.MyFlorida.com, or by phone at 850.245.6333.

Sincerely

Robert F. Bendus, Director
Division of Historical Resources
and State Historic Preservation Officer